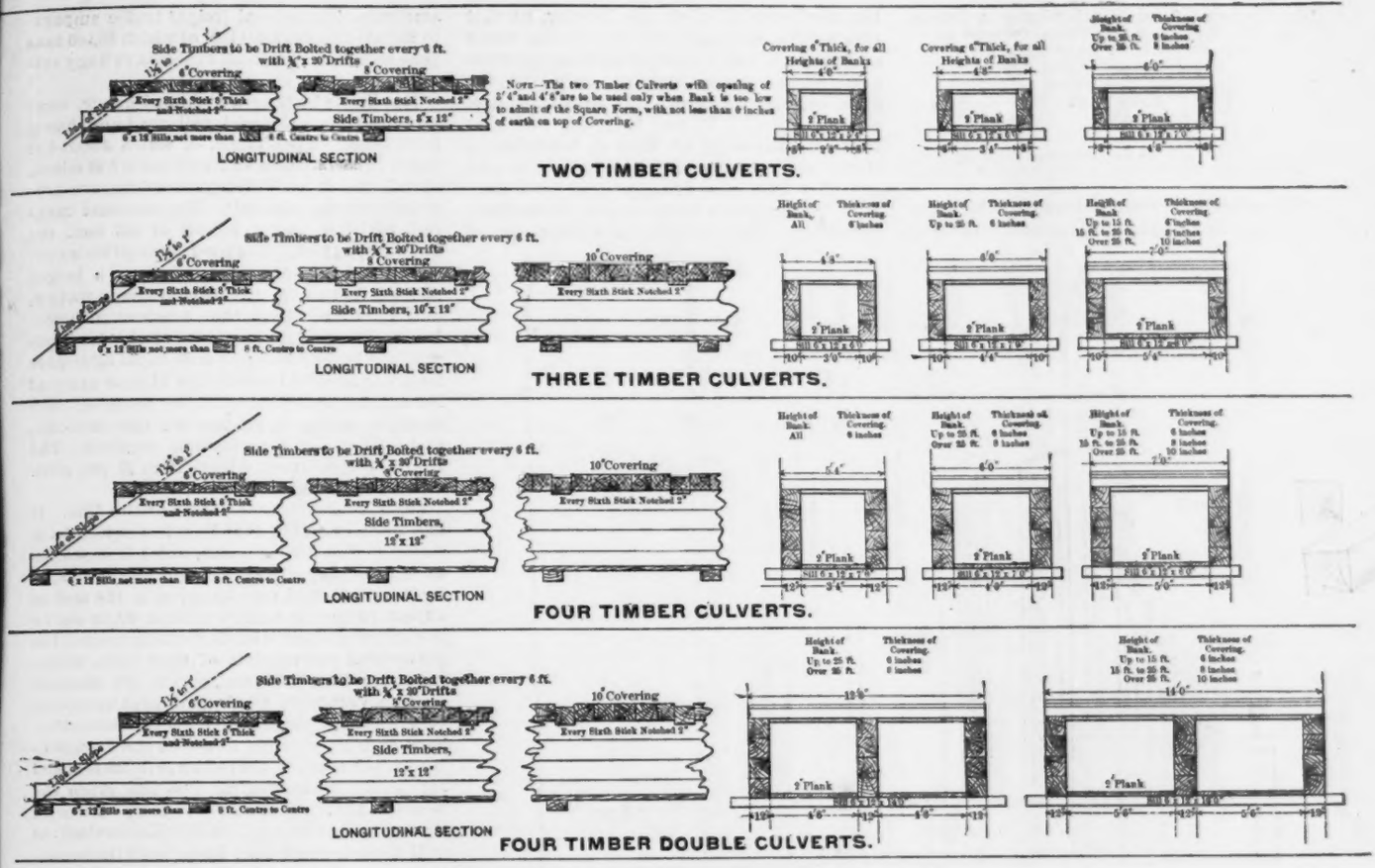
Side Timbers to be Drift Bolted together every 6 ft. with ¾"x 20" Drifts
6" Covering
8" Covering
Every Sixth Stick 6" Thick and Notched 2"
Every Sixth Stick Notched 2"
Side Timbers, 8"x 12"
6"x 12" Sills not more than 6 ft. Centre to Centre
LONGITUDINAL SECTION
Note.—The two Timber Culverts with opening of 2'4" and 4'6" are to be used only when Bank is too low to admit of the Square Form, with not less than 6 inches of earth on top of Covering.
Covering 6" Thick, for all Heights of Banks
Height of Bank. Thickness of Covering.
Up to 25 ft. 6 inches
Over 25 ft. 8 inches
2" Plank
TWO TIMBER CULVERTS.
Side Timbers to be Drift Bolted together every 6 ft. with ¾"x 20" Drifts
6" Covering
8" Covering
10" Covering
Every Sixth Stick 6" Thick and Notched 2"
Every Sixth Stick Notched 2"
Side Timbers, 10"x 12"
6"x 12" Sills not more than 6 ft. Centre to Centre
LONGITUDINAL SECTION
Height of Bank. Thickness of Covering.
All 6 inches
Up to 25 ft. 6 inches
Up to 15 ft. 6 inches
15 ft. to 25 ft. 8 inches
Over 25 ft. 10 inches
2" Plank
THREE TIMBER CULVERTS.
Side Timbers to be Drift Bolted together every 6 ft. with ¾"x 20" Drifts
6" Covering
8" Covering
10" Covering
Every Sixth Stick 6" Thick and Notched 2"
Every Sixth Stick Notched 2"
Side Timbers, 12"x 12"
6"x 12" Sills not more than 6 ft. Centre to Centre
LONGITUDINAL SECTION
Height of Bank. Thickness of Covering.
All 6 inches
Up to 25 ft. 6 inches
Over 25 ft. 8 inches
Up to 15 ft. 6 inches
15 ft. to 25 ft. 8 inches
Over 25 ft. 10 inches
2" Plank
FOUR TIMBER CULVERTS.
Side Timbers to be Drift Bolted together every 6 ft. with ¾"x 20" Drifts
6" Covering
8" Covering
10" Covering
Every Sixth Stick 6" Thick and Notched 2"
Every Sixth Stick Notched 2"
Side Timbers, 12"x 12"
6"x 12" Sills not more than 6 ft. Centre to Centre
LONGITUDINAL SECTION
Height of Bank. Thickness of Covering.
Up to 25 ft. 6 inches
Over 25 ft. 8 inches
Up to 15 ft. 6 inches
15 ft. to 25 ft. 8 inches
Over 25 ft. 10 inches
2" Plank
FOUR TIMBER DOUBLE CULVERTS.

Standard Timber Box Culverts—Chicago, Milwaukee & St. Paul Railway.

Standard Timber Box Culverts, Chicago, Milwaukee & St. Paul Railway.

Reprinted from the Railroad Gazette.

There is a strong feeling among engineers, which finds expression in the construction of nearly all lines on which timber is used at all, that the use of timber box culverts is bad practice; that where the fill is not over 6 or 8 feet high—or some times even 10 feet high—open timber culverts should be used instead, and where the fill is too great for such open culverts, pile or timber trestles should be used, or else masonry. The practice of the Chicago, Milwaukee & St. Paul is different from this, on all the thousands of miles which it has built or is building, where stone cannot be obtained at all, or only with much difficulty and cost. In such cases, the rule on that line, even in timber work, is never to use an open culvert when timber can be used instead. In this it is not alone, but we believe it is fairly entitled to the credit of having set the fashion, which is not yet a very general fashion.

It is defended by the following argument: That though it is true that the wood decays, and though it is true that there is somewhat less certainty of knowing of dangerous decay in advance, yet it is not true that decay is more rapid than with open structures, nor that they are as likely to give way when they are decayed, nor that the consequences are likely to be so serious if they do give way. In the meantime the average condition of a poorly ballasted or wholly unballasted track is very much better than with open structures.

Therefore, the practice on that line is to use timber box culverts wherever possible, to have them inspected periodically and carefully, and whenever their condition demands it and convenience serves, to renew them, not with stone but, as a rule, with iron pipes. It is not found in practice, however, that even a considerable amount of decay endangers caving in of the bank greatly, especially when the bank is of some considerable height. After the bank has once become solid, on the contrary, which of course is long before the timber begins to decay seriously, it is found that they very seldom cave in, and that in putting in the iron pipe the timber may be almost completely cut away at top, bottom and sides for the insertion of circular pipes without danger; a safe indication for the workmen being that wherever the timber is punky and rotten there can be no immediate danger in removing it altogether, and after the expiration of very much less than 15 or 20 years, which is no unusual time for these culverts to remain in service, all the interior of the wood at least where it is exposed to the air, is pretty sure to be punky and rotten, its chief and all-sufficient function seeming to be to sustain the pressure of earth during the process of solidification only, and thereafter chiefly to protect the interior surface of the earth fill from the influence of the atmosphere, which alone suffices to restrain all considerable tendency to cave.

It follows that the size of the iron pipes which are ordinarily used for renewal, when it is not clearly safe to use a smaller pipe, will be given by determining with a pair of dividers the largest circle which can be drawn within the exterior limits of the culvert walls without cutting away more than half or two-thirds of the thickness of the wood at top or sides at any point, the greatest liberties being taken of course with bottom timbers. In doing this, the first section of the pipes is entered at one end and drawn clear through to the other end by appropriate tackle, the workmen clearing away in advance of it. After the first pipe has been drawn through and placed in position, the following pipes are drawn up to it in succession, one after another, very speedily, and the whole work is complete. A masonry end may or may not be added. The pipes used range from 24 to 60 in. in diameter, and are cast at the company's foundry of any scrap which comes convenient. They are provided with a simple bell mouth large enough merely to hold the pipes in line with each other, without any attempt at calking.

The sizes of pipe used, of course, depend largely on what has proved to be the requirements of the water way. When the culvert has been in use some years the presumption is fair that no larger water way than before is necessary, and this, or even more, is readily obtained by pipes in the manner described.

Whether or not this manner of using and renewing wood is good and safe practice is simply a matter of experience. Experience in almost all kinds of soil appears to indicate that it is, a notable advantage being that in the rare cases where culverts cave in they do not, as a rule, produce a dangerous disturbance of the surface, whereas if an open culvert or trestle has been carelessly allowed to become too weak, an accident is almost certain, while it is almost impossible to make a new track with many open structures in it ride even fairly well.

There is perhaps no detail of American practice in which foreign critics accustomed to new lines made thoroughly solid and complete before they are allowed to be opened, are more apt to comment unfavorably than on the practice of opening first with temporary works, and completing with permanent works afterwards, which may be called the standard American practice. Yet there is much to be said for it.

There are three other considerations of great weight:

First.—The exact requirements of the locality become better known, and costly and dangerous mistakes may be more fully avoided.

Second.—The work can be prosecuted in a more leisurely manner and at more appropriate seasons, and thus greater durability insured.

Third.—The work can be prosecuted more cheaply, there being the advantage of locomotive power for delivering stone, cement and iron work, and for making fills by trains; often at but a fraction of the cost of executing the permanent works in advance of these facilities.

As for safety, there is no question but that wooden structures, properly designed and properly watched and renewed, are entirely safe, and the thing to be protested against therefore is lack of care and skill in using them and not the things themselves. The difference in the cost of a good and of a bad wooden structure is not so great that there is ever any excuse for the latter, though it must be admitted that they are far from unknown.

For these reasons there is no apology demanded for the reasonable and cautious use of the practice of "opening roads first and building them afterwards," as it has been called, even when, as on the Chicago, Milwaukee & St. Paul and thousands of miles of other road in the West, the use of stone structures for opening the road is wholly out of the question.

BURLINGTON, VT., will spend $24,000 on the improvement of its water-works.

The Railway from Blankenburg to Tanne in the Harz and the Freight Road to Oertelsbruch in Thuringia on the Combined Adhesion and Rack-Rail System of Abt.

Specially translated for ENGINEERING NEWS from the "*Wochenschrift des Oesterr. Ing. und Arch. Vereines.*"

The writer was commissioned by the Union Construction Company last January to go to Germany and make a practical study on the spot of two rack railroads that had been built upon the Roman Abt system. So much that is really new in railway engineering is for the first time practically presented in the building of these roads that some account of them would seem to be desirable.

The first planned and the more important of the two, is the standard gauge line from Blankenburg to Tanne, in the Harz mountains, which has been constructed for a considerable freight and passenger traffic. The second is a standard gauge freight road, which starts from the station at Lehesten and forms the continuation of the branch line Ludwigsdorf —Lehesten to the important slate quarries of Councillor Carl Oertel.

It must be stated as a characteristic of the first of these lines that the Harz-range forms a compact mass without any proper through-valleys, and rises some 1,970 feet on an average above the North German plain.

The German railway network extends its ramifications to the foot of the mountains, but few roads could reach the interior, so that this region, although rich in woods, mines and quarries, had to remain until lately without railway communication, owing to the great expense attending the construction of adhesion roads. It was only last year that through the energy of Herr A. Schneider,—Herzogl. Braunschw Bahndirector—his project of a line from Blankenburg via Ruebeland to Tanne was adopted and successfully completed. The line takes in a large part of the Harz, as it connects Huettenrode with its mines, Ruebeland with smelting and charcoal works, Elbingerode with lime quarries, Rothehuette and Tanne with State smelters. The annual freight traffic amount to 200,000 tons (at 2,000 lbs) of which 88,000 tons pass over into the great Prussian railway system.

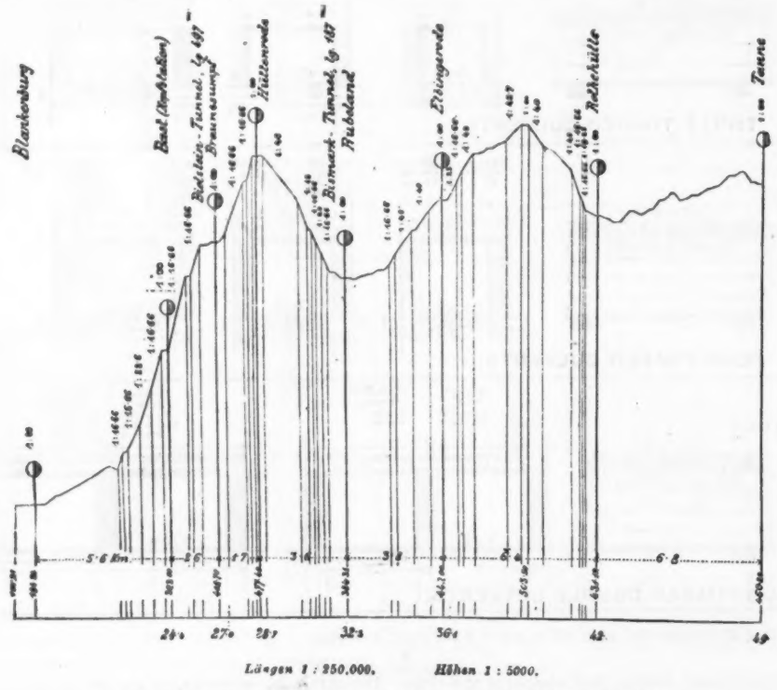

Fig. 1.—Profile of Railway on Abt System. Blankenburg to Janne.

The line is built as a standard guage, combined adhesion and rack-rail road and has a total length of 16.8 miles, of which about 4.12 miles (with entering and exit parts 4.85 miles), distributed at ten different locations, are provided with the rack-rail. The smallest rack-rail division has a length of 935 feet, the largest 5,082 feet. The road crosses two watersheds, and rises at the second one to a height of 1,000 feet above the Blankenburg station, and 1,650 feet above the Amsterdam water level. The maximum grade of the rack-rail portions is 316.8 feet per mile in an aggregate length of about 3.1 miles; the highest grade of the adhesion portions is 132 feet per mile. The smallest radius is 820 feet for the rack-rail, and 591 feet for the adhesion sections. The length of the curves is more than 50 per cent. of the road length.

Fig. 1. represents the profile of the line. It has yet to be stated that Bast is a switch-back station. This arrangement, which is so seldom used, is worthy of imitation for local roads, as by it a great deal may be saved in the cost of superstructure in narrow valleys, while only a few minutes time are lost in working trains. The permanent way consists of steel rails, weighing 60.3 pounds per yard, which are fastened on iron Vautherin ties by iron keys according to a system modified by Director Schneider. This system, which is in use on the Bergisch-maerkisch road, on the railways in Baden, and also on the Swiss Central line has given the best results, according to Herr Director Schneider's statement, on the Halberstadt as well as on the new line. Especially the two inside cross-ribs at each tie, made by pieces of riveted angle iron are, said to have greatly contributed to the stability of the road-bed. The rail joints are between ties, the rack-rail is fastened to the ties upon the same system of keys, and it is stated that no complaint has been heard during the nine months the section has been in operation. The arrangement of the permanent way is shown in Fig. 2; the

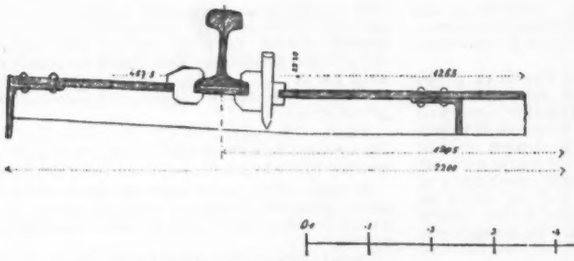

Fig. 2.—Fastening of Adhesion Rails.

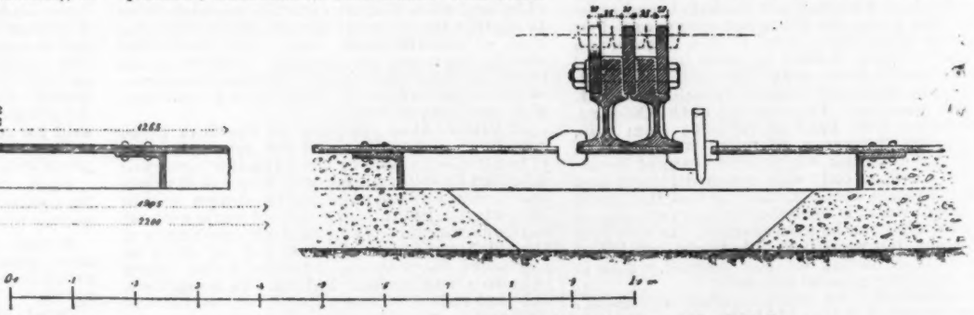

Fig. 3.—Cross Section of Rack-Rail.

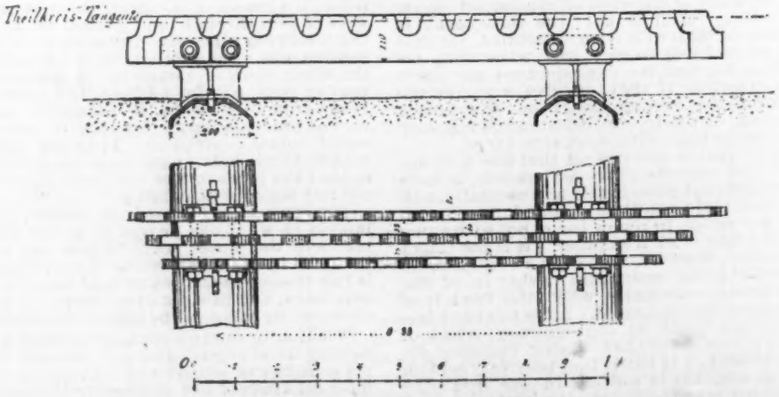

Fig. 4.—Elevation and Plan of Rack-Rail.

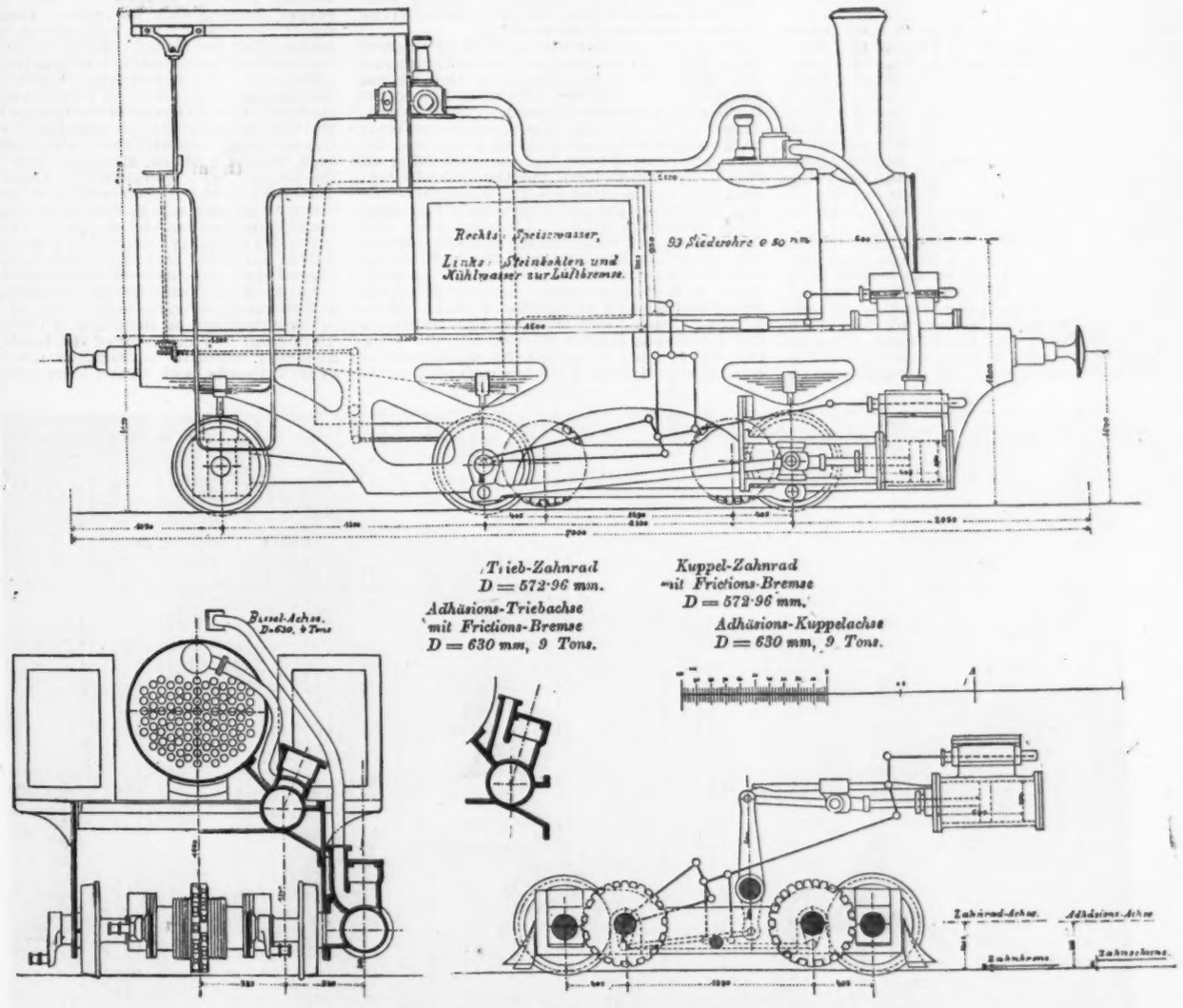

Fig. 5.—Locomotive for Freight Branch to Oertelsbranch. Abt System.

iron ties with cross-ribs weigh 90 pounds apiece.

It was originally contemplated to make use also for the Harz road of the Riggenbach rack-rail*, everywhere else applied up to that time. There was the objection, however, that this system, although it has proved very satisfactory for small roads, specially pure rack-rail lines, could never be applied to a line having a large traffic, as the system in itself admits of only very low speeds, so that even light passenger trains could not travel any faster than heavy freight trains, and in addition to this, when operating roads on the combined system there are certain defects in the construction of the locomotives which make the working of longer adhesion sections unfavorable. (See the Report on Rack-railroads by the Sub-Committee of the Union of German Railway Managements.) These facts led Director Schneider to examine into the system of a multiple rack-rail with stepped teeth as proposed by Roman Abt, formerly Chief Engineer of the Riggenbach works in Aarau, and apply it to the Harz road.

The rack-rail of the Harz line (Fig. 3) consists of three rack plates or bars of rectangular section, each plate 0.787 inches thick, 4.33 inches in height, and 8 feet 7.8 inches in length. Owing to the slight thickness of the plates they can be used for the curves as well as for the straight portions of the road, and this greatly simplifies the manufacture and the laying of the rack-rail. The plates are fastened on chairs of steel castings in such a manner that only one joint comes to each chair. Consequently along with every joint of two plate ends, there are two solid plates that pass through, and as each plate extends over three tie distances, there is one joint at each tie. The distance from center to center of the ties is 34.646 inches, and, with the length of the plates, 8 feet 7.8 inches, there consequently remains 0.157 inch play for variations of temperature.

The pitch for all the plates is perfectly uniform: to accomplish this the Dortmund Union has made special machinery. The material used is a Bessemer iron of excellent quality; the fracture is very finely laminated, and the material, therefore, very soft and tough. Professor Bauschinger, of Munich, tested one of the plates furnished by the Dortmund Union in a way to correspond to the usual straining in regular service, viz., by a force attacking the teeth of the plate at an angle of 12° 36′ with the horizontal. With a distance between ties of 34.646 inches, Professor Bauschinger found that the *admissible* rack-rail traction against a deflection amounts to 11,700 pounds and against shearing of a tooth to 14,150 pounds for one plate, and at these figures the factor of safety is four. Three plates and two driving pinions are used on the Harz railway. The entire rack-rail traction would, therefore, be $2 \times 3 \times 11{,}700 = 70{,}200$ lbs., but the actual rack-rail strain on ascending gradients never exceeds as a rule 13,200 pounds, and in exceptional cases it is as great on a descending track when no brakes are applied on the cars, and it is always far less when the cars are braked. The coefficient of safety is therefore twenty fold for the rack-rail against deflection, and twenty-five fold against shearing. Measured on the tangent to the pitch circles the spaces between two teeth and the width of the teeth are both 2.36 inches. The teeth of the pinion on the other hand have a width of 2.125 inches on the pitch circle, and as the pitch itself is 4.72 inches, the space between two teeth of the pinion is 2.6 inches. The flanks of the plate teeth have an inclination of 1 in 4, and the flanks of the pinion teeth are cut according to the involute of the pitch circle.

The plates are stepped against each other by one-third of the pitch or by 1.573 inches. The two coupled pinions, placed behind one another in line of the rack-rail, consist each of three separate disks provided with teeth. The different disks are again displaced or stepped against one another by the amount of 1.573 inches, in correspondence to the plates of the rail, and the pinions are themselves so arranged on their axles that they are stepped by one-sixth of the pitch or 0.7865 inches. It follows from this arrangement that for every

*Erroneously so-called. It is substantially the rack-rail which was first introduced by Sylvester Marsh on his Mt. Washington railway. Riggenbach, who was acquainted with Marsh's rail, modified it somewhat without altering its principle.—(Ed.

0.7865 inches of the rack-rail a new tooth must come into contact. The very moment one tooth enters contact five other ones are in full interlocking. Similar to all lines of the combined system the rack-rail is placed higher than the adhesion rails. On the Harz railway this elevation amounts to 2.76 inches. Finally it must be stated that tamping has only to be done under the two adhesion rails but that in the middle under the rack-rail no bed is made, so that a kind of ditch is formed along the road axis for the purpose—when the adhesion rails settle—of preventing any bending of the ties and consequently any change in the depth of interlocking of the teeth.

From the described arrangement of the rack-rail and the pinions it follows that the continuity of the rack-rail is as perfect as it possibly could be, and that there is a far greater security against the breaking of teeth than in the ordinary ladder rail (the type of Sylvester Marsh and Riggenbach), because stepping of the teeth always establishes five simultaneous contacts. In consequence of with a wooden snow plough, the cutting point of which was shaped in correspondence to the elevated position of the rack-rail.

Fresh fallen snow forms a kind of vault or crust between the plates of the rack-rail and the ditch-like arrangement of the ballast along the road axis, and this vault-like covering is simply pressed through by the pinions. However, the problem of removing snow from rack-railroads has already been resolved by an experience of over ten years standing on the Rorschach-Heiden, the Ostermundingen, and also on the railways in Wasseralfingen and Friedrichsegen, all which are in full operation during the winter. All these roads run through a most unfavorable climatic region, and yet a plow-like device in front of the locomotive has all this time been amply sufficient to keep the track clear, even during heavy storms, and with drifts of over 3 feet in height. During eleven years the traffic on the Rorschach-Heiden railway has not been once interrupted by snow drifts, a thing which occurs several times a year in unfavorable locking does not happen at once, then the pinion, striking with its outside diameter on top of the entering rail, rolls along upon the latter. But the rolling contact occuring thus in a circle of larger diameter than that of the pitch circle, which latter alone corresponds in the lengths of its divisions with those of the rack-rail, the difference in the motion between the two circles is always sufficient to lead to interlocking. It will take place after one-half, or at the utmost, after one full turn of the pinion, which would give, in round figures, a length (of the entering rail) of 6 feet. The entering of rack-rail section is, of course, accomplished without any stoppage of the train, the speed is simply reduced to four and one-half or five miles, and may be increased again immediately after contact is established. The location of the entering rail is designated by a disk, having on one side the letter *A* (*Anfang*—beginning) and on the other *E* (*Ende*—end). To prevent any creeping of the track, simple and very effective anchorages are used at every 220 yards, both on the Harz railway and

Harz Railway upon the Abt System. Station at Bast.

the above dispositions the motion of the engine is very easy, and free from jolts, while the speed can be brought up unhesitatingly to twelve and one-half miles an hour when the proportion of the load to the engine power allows it. The writer rode over the Harz railway, standing on the locomotive and also sitting in the cars, and he can positively affirm that unless the rack-rail sections had not been discernible by the inclination of the cars, or by looking at the track, it would have been impossible to tell whether one were traveling on an adhesion or a rack-rail section.

As to the apprehensions that a heavy snow storm would prove a greater hindrance to travel on such a road, than on one operated by adhesion alone, I could ascertain myself that the free position of the rack-rail prevents any clogging with snow. The snowfall on the Harz at the time was not uncommonly heavy, but at Lehesten such a quantity had fallen a short time before my arrival, that the rock cuttings of the branch line Lehesten-Ludwigsdorf were choked up and had to be dug out. There are no such cuttings on the freight extension to Oertelsbruch, and in order to clear the road it was perfectly sufficient to pass it

calities on adhesion roads. This phenomenon is explicable by the fact that on rack-railroads the traction of the locomotive, owing to the rack-rail, can *always attain its full efficiency quite independent of the state of the rails*, while on adhesion lines, whenever the well-known co-efficient—the Achilles heel of the adhesion system—is diminished, every effort of the engine is in vain, the adhesion becomes less than the traction, the wheels slip and the train does not move from the spot. The automatic entering parts or entering rails to the rack-rail sections differ materially from those on the Riggenbach roads. The pitch throughout is the same. The teeth toward the entering end are, so to say, partially clipped and rounded off, their upper contour presenting a gently rising line. The entering rail is fastened by hinge joints to the fixed rack-rail of the road, and the wedge-shaped entering end is bent downwards in beak form so as to prevent suspended couplings, chains, etc., of the cars from being caught in the cogs. The whole entering rail rests on four springs, so that, when a tooth of a pinion strikes upon a tooth of the entering rail, the latter gives way. The play is about 2 inches. When proper interthe Oertelsbruch freight extension. All the switches and crossings occur in the adhesion portions so that there was no opportunity on either line to test the proposed system of Herr Abt for rack-rail switches.

The standard-gauge freight road to Oertelsbruch has a rack-rail section of 4100 feet in length with a maximum grade of 8 per cent. or 422.4 feet per mile. The maximum gradient of the adhesion road is 3 per cent. or 158.4 feet per mile. As the annual freight is here merely 33,000 tons (of 2,000 pounds,) a train weight of 55 tons, exclusive of the locomotive, is sufficient. Accordingly the whole superstructure has been built lighter. The rails weigh 51.4 pounds per yard. The rack-rail is formed of two bars only. Shape and size of the latter are exactly like those of the Harz railway.

The fastening to the iron ties has here been done upon the well-known Roth & Schueler system, a system also recommended by the firm of Rinecker, Abt & Co. of Wurzburg.* The iron sleepers, which are 8 feet 2½ inches in length, weigh 96 pounds.

* Mr. Otto Grüninger, C. E., 24 Whitehall street, New York, is representing the Abt system of railway for the Continent of America.—[Ed.

Just as his new form of rack-rail designates an important advance in the developement of rack railways so also has Herr Abt ingeniously solved the problem to construct an engine which would prove perfectly satisfactory to all the demands of a combined system. Already at the Paris exhibition of 1878 Riggenbach proposed in a pamphlet to separate the two mechanical devices on locomotives upon the combined system, an idea which later on was farther pursued by the technical sub-committee of the Union of German Railway Managements, and pronounced to be the very type by which at last an engine upon the combined system might be obtained, capable of also running with economy over longer adhesion sections. Abt's design which is the realization of this idea, rests upon the principle to utilize the natural adhesion of the locomotive on all railways which have a heavy traffic and which (with a heavy traffic) may have gradients up to 8 per cent. or about 422 feet per mile, so that the pinion will not have to carry the burden of the total traction, but only that portion of it which natural adhesion cannot from the two outer adhesion axles. This disposition offers several advantages. In the first place, the interlocking and contact of the pinions is thus altogether independent of the play of the springs; it further allows to raise from time to time the axles of the pinions in proportion to the wear of the adhesion tires, and finally the entire pinion mechanism is thus no dead weight, but contributes to produce adhesion. The two pinions are coupled together, the rear one being thedriving wheel. The motion is transmitted to the driving axle by means of two rockers and the supplementary driving rods. To each pinion are attached two brake disks, so that there are four in all, the shoes of which are operated from one and the same hand wheel. A second hand wheel commands the brakes of the two outer adhesion axles. Besides these, the engine has two separate working air brakes,—one for the adhesion and the other for the pinion cylinders.* The other details are carried through after the usual custom, except that certain parts appear in duplicate, owing to the peculiarity of having two complete steam-engines under one tons. The weight of the train was, in round numbers, exclusive of the engine, 61.6 tons. The speed on the ascending gradients was about 8¾ to 9½ miles, and on the rack-rail sections, only 7½ miles. The admission of steam was below 50%, and the steam gauge showed 150 pounds all the time. It was evident that it was the merest play for the engine to do the work. In Ruebeland the engine left the empty train and took one consisting of six high boarded lorries loaded with stone, a covered freight car and the passenger car before mentioned. The weight of this train was in round numbers 131 tons. The speed both on the up grade from Ruebeland to Huettenrode and also on the down grade was 7½ miles, the time lost by stopping at stations having been deducted. The officially prescribed time inclusive of stoppages is one hour thirty-seven minutes, the net running time 1.08 hours, or 7½ miles per hour, and the speed has been fixed at present at 9½ miles for the adhesion portions and at 4¾ miles for the rack-rail divisions. During the coming summer passenger travel will be introduced on the entire

Harz Railway upon the Abt System. View of Entering Rail.

any more exert. Besides this the locomotive must be able to develop its full working capacity on the adhesion sections as well as on the rack-rail, that is, with the same train weight it must be able to run there at a correspondingly higher speed. The Harz locomotive fulfills these conditions in every respect.

The detailed drawings of the Harz locomotive were given by Herr Director Schneider, in Glaser's Annalen, Vol. XVII, No. 198. In illustration of the system Fig. 5 is a sketch of the Oertelsbruch locomotive, which is built on the same principles as the Harz engine.

The Harz locomotive is built as a tank engine; it has three coupled adhesion axles, placed before the fire-box. A two-wheeled Bissell truck is under the cab, with its fulcrum under the ash-box. When in working order, each driving axle is loaded with 32,000 pounds and the Bissel axle with 27,250 pounds. The fuel and feed water rest mostly on the Bissel axle so that their variations have very little effect on the adhesion. The locomotive has four cylinders; one pair for the adhesion engine, and the other for the pinion engine. They have separate steam conduits, and work completely independent of one another. The adhesion cylinders lie outside, the cog-wheel cylinders inside, under the smoke box. Their location and construction may be considered as most suitable. The pinion mechanism is suspended by means of a second pair of frames

boiler. The principal dimensions of the Harz locomotive are as follows:

Outside cylinders	18 × 23½ inches
Inside cylinders	12 × 23½ inches
Diam. of adhesion drivers	49 inches
Diam. of truck wheels	29½ inches
Diam. of pinion	23½ inches
Total wheelbase	17.9 feet
Rigid wheelbase	10 feet
Grate area	20.1 sq. feet
Heating surface of fire-box	89. " "
Heating surface of flues	1540 " "
Total heating surface	1629 " "
Diam. of flues	1.77 inches
Number of flues	251
Boiler pressure	150 pounds
Weight of engine empty	100,600 "
Weight of engine in working order	123,000 "
Capacity of tank for water	1,200 gallons
Fuel	4,400 pounds

The Harz engine can develop a traction of 25,300 pounds at a speed of 7½ miles per hour. With a speed of 15½ miles the tractive force is 12,150 pounds. This, in round numbers, is equivalent to 500 effective H. P., and the locomotive could therefore pull a train of 132 tons at 7½ miles per hour on a gradient of six per cent (316.8 feet per mile) or draw the same train at a speed of 15½ miles on a gradient of 2½ per cent. (132 feet per mile). These are remarkably great performances.

The train on which I rode on my outward trip consisted of seven empty freight cars and one passenger car, which latter weighed 14.4

*These air-brakes are devices by means of which the steam cylinders act—without injury to any part—as air compressors on down grades.

line, and the speed will be increased. The low speed is not due to the system, for I, myself, rode on the Harz railway onthe 61.6 ton train at more than 7½ miles over the gradients of six per cent., and on the Oertelsbruch road at over 12½ miles over a grade of eight per cent. (in this case without train however), but this low rate is owing to the excessive caution of the authorities with respect to a novel system.

It must be stated that Herr Director Schneider has given instructions that on down grades no braking be done by the brakes on the cars although the prescribed number of brake cars, are in the train. All braking is entirely done by the two air brakes of the locomotive. This disposition has the great advantage of saving tires; it is evident, however, that if the *vis-viva* of the train would be regulated by the car brakes themselves, as is customary on all adhesion lines with steep gradients, the locomotive would be considerably relieved and the speed, even with heavy trains, could with impunity be made far greater.

There are four such locomotives on the Harz road. They were manufactured by the Esslingen Locomotive Works. The 'Prince Albrecht' was the first built, it has run up to to-day over 1,250 miles of the rack-rail without requiring the slightest repair. The fuel used are "bricks" made from Westphalian coal. The rolling stock consists of six passenger and two combined baggage and postal cars provided with the Heberlein brake, thirty open and six housed freight cars, one parlor day car and

six lorries. A great part of the transportation is done with cars of other lines. The passenger cars were originally provided with pinion brakes, but they were subsequently taken off, as being entirely superfluous.

The buildings are mostly of frame work, filled in with brick, and they are exceedingly plain. The substructure of the line necessitated a good deal of work; deep rock cuttings and high retaining walls are not unfrequent. Two tunnels were also called for, one 1,635 feet and the other 614 feet in length. Both are faced with ashlar masonry, and cost together $46,300; it is to be mentioned, however, that the first tunnel had previously existed, and was now made part of the line by a skilled development of the latter. It had served the mining tramways of the Harz works at Ruebeland and Zorge. The tracks were laid on different levels, and the ores were hauled to the furnaces from level to level by shafts and inclined planes. Now the ores are transported over the rack-railroad. As part of the line is not yet completed, only the original estimates of cost can be given.

Real estate	$35,000
Earth and rock excavation, including retaining walls	187,500
Fencing of depot yards	1,250
Crossings	10,000
Culverts and bridges, including a bridge with four arches of an aggregate span of 115 feet	25,000
Tunnels	17,500
Superstructure with sidings	245,000
Signals, including line telegraph, electric bells and guard houses	8,750
Depot buildings and stopping places	55,000
Workshops	6,250
Divers expenses	6,550
Rolling stock	142,500
Exigencies	50,000
Interest during construction	70,000
First payment to reserve funds	15,000
Total	$875,000

or in round figures $52,000 per mile.

Of these original estimates only the item of "tunnels" was transgressed by $28,750; all the others show considerable savings, so that the final cost will certainly fall below the above total. On November 1st, of last year, regular freight service was opened as far as Ruebeland. As already mentioned the line will be completed to Tanne during the summer, and will also be opened to passenger traffic.

Before finishing this short report, I must mention the interesting application Abt's rack-rail has found in the imposing slate quarries of Councillor Herr von Oertel. As already stated, the standard-gauge freight branch which connects the quarries with Lehesten reaches down to the lower storage-houses. But the quarries are worked in different levels, and each level has a splitting house, storage sheds for finished material, and several miles of track (altogether over 10 miles) for dumping the debris. The building of the freight branch necessitated the connection of the tracks of the different levels with one another and with the loading or rather re-loading station. This was done by inclined planes, four in number, with a gradient of 724 feet per mile, and by the application of a two-part-rack-rail of 0.59 inch in thickness (each bar). All the tracks in the quarries have a gauge of 27.1 inches. The rails weigh 24.1 pounds per yard, and are fastened, as might be expected, to soft wooden ties. The small locomotive upon the combined system weighes 14,000 pounds in working order, has but one pinion and only two cylinders, and can haul three loaded trucks of 2¾ tons useful load and 1 ton own weight each—in all, therefore, 11¼ tons—on the above gradient. The locomotive of the standard-gauge freight branch, and as illustrated in Fig. 5, is built entirely after the type of the Harz engine. It differs in so far as to correspond to its considerably lower duty; it possess but two adhesion axles, and has various modifications of detail. The engine was built by the locomotive works in Winterthur, and upon trial it surpassed the stipulations of the contract in every respect.

In these three roads the rack-rail of the Abt system has been made use of under very different circumstances. In the Harz line we see the case of a more extensive mountain railway with a large traffic; the freight branch from Lehesten to Oertelsbruch presents, in a measure, the more modest requirements of a local road, while the narrow gauge applications in the Oertel quarries are an example of a line for purely industrial purposes. The Harz railway which is half finished, has already been in operation for nine months, the other two were only opened to traffic a few weeks ago.

By giving a description of these three applications, I have endeavored to show that the apprehensions, which until now prevailed against the use of rack-rail sections on ordinary adhesion roads, are to-day completely done away with. The aim, which for years has been hunted after, of separating the two mechanical devices, is now reached practically with undisputable success; and more than this, a rack-rail has been developed, which with a far greater security admits also of greater speeds, and besides is of considerably cheaper manufacture than the hitherto used ladder type of rail.

Especially in mountainous districts, the valleys of which long for connections with existing railways, how many hundreds of miles of surperfluous developments of the roads might be saved by a judicious use of rack-rail sections! Both from an engineering point of view and also in regard to its economical significance, this subject appears to me as of extraordinary importance, and fully deserving the attention of the Austrian engineers.

VIENNA, in February, 1886.

J. MUTINELLI, C. E.

NOTE.—From a paper of Mr. ABADIE on Rack-Railroad, published in the *Genie Civil*, Paris, 1886, we have added to the above article two cuts after photographs from the Harz Railway. Both give views of entering rails; and one is also the loading station at Bast.—[ED.

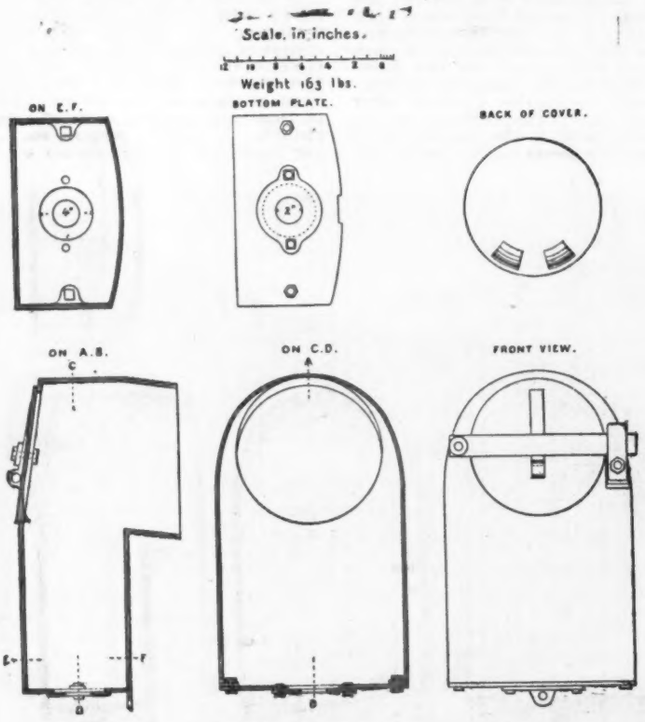

Plate 23. Throttling Trap.

Municipal Engineering; Paper No. 2.*

PROVIDENCE, RHODE ISLAND.

(*Continued from Page 293*).

To assist in the ventilation of the private drain the stand pipe from the trap is usually brought to the surface and covered with a perforated cast-iron cover.

The throttling trap is represented in Plate 23, and is shown in detail. A throttling plate to be used in connection with the Hood trap is also shown in Plate 24, and these plates are put into the mouth of the outlet pipe under the trap.

A modified form of trap designed by J. J. R. Croes, C. E., of New York, that has been adopted here is shown in Plates 18-18*a*. (See page 292.)

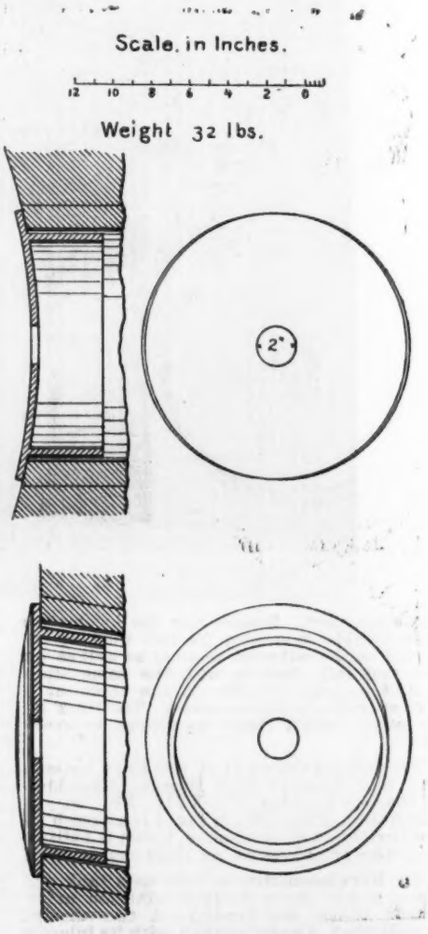

Plate 24. Throttling Plate.

The practice as regards depth of sewers has varied. When the system was commenced the depth was established at 8½ feet below the street grade to the inside crown of the sewer. In the spring of 1874 the depth was increased

* Copyrighted by ENGINEERING NEWS PUBLISHING Co., 1886.

to 10 feet and again early in 1875 it was fixed at 11 feet, which has been the ruling depth ever since. January 1, 1886, there were, 10.26 miles of sewer with a ruling depth of 8.5 feet to crown; 12.06 miles of sewer with a ruling depth of 10.0 feet to crown; 30.73 miles of sewer with a ruling depth of 11.0 feet to crown.

The depth of 11 feet was fixed upon as it allowed the private drain, laid at the minimum grade from the sewer, to reach a point 100 feet from the street line, and be below the grade of the curb. See Plate 22, page 294.

There are 1.89 miles of storm sewer in the city, of which .68 miles was built to take the surface water from streets already sewered, the balance being in suburban streets. Sheet shows the position occupied in the street.

Connected with the sewer department is the sewer Maintenance Department, in charge of a superintendent, whose duty it is to examine the sewers and catch-basins (both the new system and the old drains), sand catchers, etc., and see that they are kept clean and in good condition. The sewers are mostly cleaned by flushing with water from hydrants, through hose under pressure. The "pill" is sometimes used in the smaller sewers. Catch-basins are filled after cleaning with fresh water from the hydrants, by means of hose. By the use of the new Croes' trap this part of the expense can be partly done away with. Owing to the completeness of the apparatus possessed by this department, it is called upon for a large amount of miscellaneous work, both for other city departments and for private individuals, such as cleaning house connections, cleaning and filling cisterns, pumping out wells, etc., supplying water in cold weather to families when the service pipes are frozen, thawing out pipes, etc.

The expense attending work performed for private parties is charged to the individuals for whom the work is done.

The sewer maintenance department is maintained by direct appropriation.

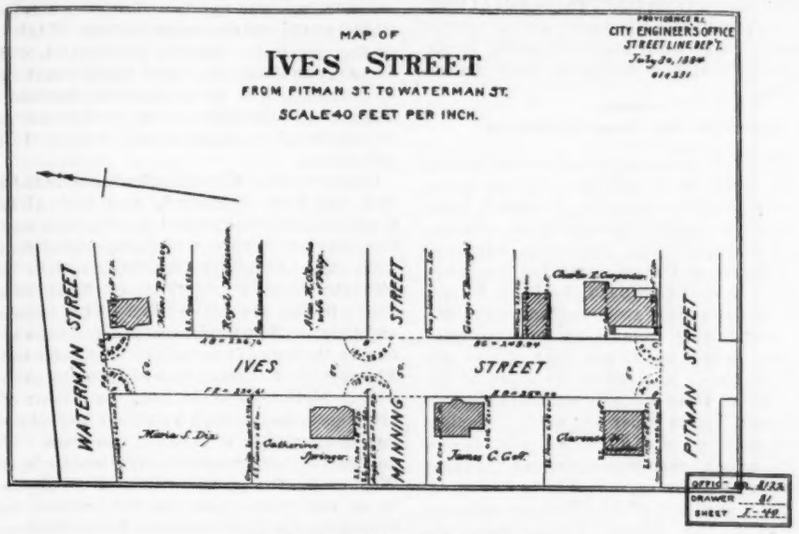

Plate 25.—Showing Plans.-Indexing.

City Surveys.

The city engineer performs all duties relative to the office of city surveyor. (See ordinance).

Official Plans—No standard scale is adopted in this office (except by the Sewer Department), the following are those most in use:—

Street Line Department: 40 feet to the inch.

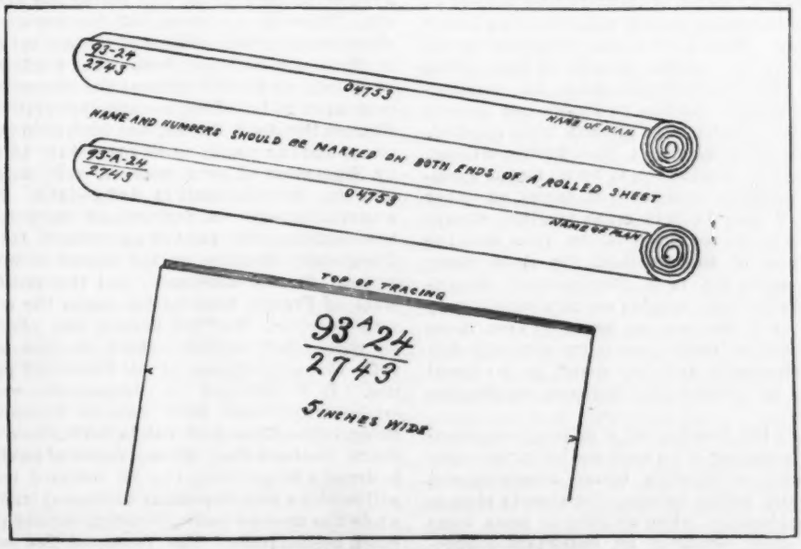

Plate 26.—Indexing Rolled Plans.

Highway Department: 40 feet to the inch, horizontal, 10 feet to the inch, vertical.

Water-works Department: 80 feet to the inch.

Sewer Department: 40 feet to the inch, horizontal, 10 feet to the inch, vertical.

City Property Department: From 20 to 80 feet to the inch and ¼ inch to the foot for building plans.

The plans in this office are divided into first, second and fourth classes. The first class includes all plans that are in constant use or liable to be needed at any time. These plans are kept by the several departments in cases provided for that purpose. (A description of the furniture of this office was published in ENGINEERING NEWS during April and May 1880).

The second class embraces all plans not required for daily use, but of sufficient value to warrant their preservation. These plans are also recorded and filed in cases.

The fourth class includes all valueless plans. These plans are not destroyed but are stored away as useless. When a plan is consigned to fourth class no record is kept of the same further than a memoranda entered in the day book.

When a plan or plate of any description is commenced it is recorded in a day book, giving the title, date made, scale, kind of paper, size of sheet, by whom made, and if an office plan the drawer and sheet location and the office number. If the plan is not to remain in the office a record is also kept in the day book of the party or committee to whom it is sent. A day book number is given the plan when entered. A cipher number is used so as not to conflict with the office number, and they run in rotation starting with 01.

If the plan is to remain on record in the office, an office number is given it, the numbers starting with 1 and running in rotation. The plan is also given a drawer and sheet location; if the drawer is divided into apartments the divisions are lettered starting with A. The accompanying plan (Plate 25) illustrates the manner of indexing.

Each department is furnished with a department rubber stamp, and the stamp in the upper right hand corner gives the style used by the Street Line Department. The date shows when the plan was made, and the number (010231) is the day book number, and is always put on the plan whether it remains in the office or not. The stamp in the lower corner explains itself.

Plans are rolled when too large to lay flat in a drawer. Tracings are usually folded. The accompanying sketch (Plate 26) shows the rolled plan and also a folded tracing.

Each department keeps an alphabetical index (by title) of the first-class plans recorded in their department, and in case a plan is taken from its drawer for any length of time, a card is placed in said drawer giving the number, and drawer, and sheet of said plan, and also the party to whom it is delivered.

(TO BE CONTINUED.)

GENERAL SPECIFICATIONS FOR HIGHWAY AND RAILROAD BRIDGES. By THEODORE COOPER.—These excellent bridge specifications, which are now received in America as embodying the standard requirements of the art, have been reprinted by the American ENGINEERING NEWS AND CONTRACT JOURNAL at the price of twenty five cents each. In them are given the various conditions of loading to be calculated for, and the amounts and intensities of wind pressures, the conditions of ordinary and exceptional loading, and the stresses per inch of section allowable with these. The allowable stresses of various numbers according to their location in a bridge are also given. These specifications, in fact, may be held to contain in as limited a a space as possible the present practice of American engineers, and just at present will no doubt receive attention from English engineers also.—*Mechanical World.*

Trans-Andean R. R.—It is stated that work on the Chilian section of the Trans-Andean Railway will be commenced in July. The section between Buenos Ayres and San Juan, which was finished May 8 is now open to the public. Chili and the Argentine Republic hope to be connected in two years.

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SUPPLEMENT.

A double page plate of the Sixteenth Street Viaduct, Omaha, Nebraska, is published this week, and must accompany each copy of this paper.

MR. JOHN O'BRIEN, of the contracting firm of Smith and O'Brien, now building a portion of the new Croton Aqueduct, has been appointed Receiver to wind up the affairs of the Broadway Railroad. The bond is $25,000 which has been filed.

THE American Water-Works Association will hold its sixth Annual Meeting at Denver, Col., June 23d, 24th and 25th.

Due notice will be given regarding programme. Railroad and hotel rates, etc.

A CORRESPONDENT, the Chief Engineer of one of the great trunk railways, wants a "clam-shell" dredging apparatus attached to a portable engine which will unload soft (or bituminous) coal from a vessel's hold to a platform about 12 feet above. To any party having such an arrangement we will forward the correspondence.

WHEN work on the Hudson River Tunnel was stopped in the fall of 1884, because of lack of funds, the north tunnel at the Jersey end had been completed some 1,600 feet from the shaft and the south tunnel not quite half so far, while the headings of the two tunnels at the New York end were about 100 and 30 feet respectively from the caisson. The water at the Jersey end, which has been flooded nearly two years, was recently pumped out. The tunnels there seem to be in as good condition as when first built.

HENRY W. JAEHNE, Ex-Vice President of the Board of New York Aldermen, is at this date wearing the striped costume of a Sing Sing convict, the penalty for accepting a bribe of $20,000 for his vote to grant the franchise to the Broadway Surface Railroad in 1884. The offense was characterized by Judge Barrett, as a most heinous one, and the verdict of the jury a just and righteous one. The sentence imposed was nine years and ten months in Sing Sing prison. The trials of the other indicted Aldermen will probably be pushed as fast as possible. The result of it all will be to purify the villainous air of metropolitan politics, and possibly strike terror into the political wire pullers of other American cities.

Railways with Steep Gradients.

Up-hill work has always been considered to be heavy work, and if anywhere, it has shown itself to be so in the operation of railway lines. On a level road and at low speeds the locomotive has principally to overcome only frictional resistances, but on ascending gradients gravity, that most obstinate of all the forces, asserts its claims in a startling manner. Frictional resistances remaining substantially unaltered, every additional foot of rise per mile of road adds irresistibly its share of retarding force. If we roundly estimate the former at about 8 pounds per ton weight, the latter for a gradient of 52.8 feet per mile, or one per cent., adds at once 20 pounds, and the ratio of traction in these two cases is as 8 to 28, or 1 : 3.5; for a gradient of 105.6 feet per mile, or two per cent., the relative figures make already the unpleasant showing of 8 to 48, or 1 : 6, and for 211.2 feet per mile, or four per cent., the ratio becomes 1 : 11. These figures are very suggestive of the rapidly diminishing hauling capacity of our engines with increasing gradients. Our trains become smaller, and the cost of transportation grows. Heavy trains demand large traction, but as the traction of our locomotives depends altogether upon the adhesion of their driving wheels on the rails, such a request calls for very heavy engines. Much good as has been done in this direction by engine designs of later years, there are limits beyond which, for constructive reasons of various kinds, we can not go; and these limits have already been reached. With a given weight on the driving wheels, the amount of adhesion is by no means a constant quantity, at times it is larger, at other times it may be very much smaller, always subject to the condition of the rails and the condition of the weather. On lines where even under the most favorable of circumstances the train weights are of necessity very light, as is the case on heavy grades, these variations in traction are more seriously felt than elsewhere, and they assist in no small degree to additionally increase working expenses.

While the location of a railway, comparatively speaking, is an easy matter in the open low-lands or through broad extensive and gradually rising valleys, the aspects change very materially, when we have to cross some water shed, establish an important connection between lines in parallel valleys, or when for local branches we have to wind our way along the narrow rapid water-courses of a mountainous district. Moderate gradients and easy curves are out of question; their places are being taken by steeper ascents together with more numerous and sharp curves, and, limited as we are in the grades by the deficiencies of our adhesion service, we seldom can avoid deep cuttings, costly embankments and a large aggregate of tunneling, all of which is synonymous with great expense. The ever present dilemma of greater cost of construction, easier grades and cheaper transportation as against a reduced building capital, steeper gradients and high working expenses necessitates in such a case the most laborious and far reaching investigations. To correctly weigh the pros and cons, and finally obtain all things considered, the most economical route through a mountainous section has always been an extremely intricate and serious problem to the engineers; yet with every display of ingenuity and skill on their part in many cases it has been, and is, impossible to arrive at satisfactory commercial solutions, solutions which would warrant a paying rate of interest on the necessary capital. Substantial, telling economy in the cost of such roads could only be obtained, if it were otherwise feasible, by using grades of sufficient rise so that the natural slopes of the ground could be more closely adhered to.

Quite recently a system of railway construction has been perfected, and has already found important practical applications on the Continent of Europe which accomplishes just such ends. Gradients far steeper than were hitherto deemed practical on lines with a heavy traffic, are worked there with economy and safety. The applications are also as various as they are interesting. We refer to the Abt system of railway in which customary adhesion sections promiscuously alternate with other sections in which a toothed rack of peculiar construction is laid on the track. The matter was first brought to our attention by Mr. Walton W. Evans, the well-known engineer, in an elaborate paper on the subject, read before the American Society of Civil Engineers in October last, and which has just been published in the March issue of the Society's transactions. The importance of the matter led us to publish an article upon the system in our number of December 26 of last year, and in the present issue we are able to follow with a description of those lines which are at present in actual operation. It is the account of an Austrian engineer, Mr. Mutinelli, who examined the lines on the spot during last January. There is no room left for any doubt about the complete success of the Abt system in these applications. Soon other roads will be added. In South Germany the system has been adopted for a long contemplated railway through the Black Forest; the work is in progress, and the road is to be opened for traffic by September of next year. A very important line is to be built in Switzerland. The western railways of Switzerland have long been suffering for want of an outlet to Italy. Their costly Simplon project cannot be built without French assistance, and the present state of French finances has made the case very hopeless. The Abt system has offered an unexpected solution which at once met with the approbation of all interested parties. It is proposed to connect the western railways from their eastern terminus, Brieg, in the Canton of Valois, with Airolo on the St. Gothard line. Thus, instead of having to dread a future rival, the St. Gothard road will receive a very important additional traffic, while the western railway system obtains the much needed relief. The projected line will have a total length of about thirty-eight miles, eleven miles of which are to be laid with the Abt rack-rail and with a maximum gradient of 316.8 feet per mile or six per cent. A charter has been applied for and the organization of the company is already secured.

The excellent point of Mr. Abt's system is that the same traffic which can now be managed by adhesion service on a line of 132 feet to the mile, or two and a half per cent., may be managed on a line containing gradients of 320 feet per mile, or over six per cent., with the same working expenses in either case. In

other words, when locating a line with an adhesion limit of 132 feet per mile, we may, by adopting the Abt system, and wherever occasion calls for, introduce gradients of 320 feet per mile without incurring any increase in the cost of transportation. Similarly rack-rail gradients of 385 and 510 feet per mile are the equivalent of adhesion gradients of 158 and 210 feet. Much of the efficiency of the Abt system is due to the speed which is admissible on the rack-rail sections. On the Harz railway the regular speed on the grades of 320 feet is 7 1-2 miles with the maximum load on, but a speed of 7 1-2 miles on such a grade is equivalent to one of eighteen miles on a gradient of 132 feet. Rack-rail sections as far as speed is concerned are in no way behind the ordinary adhesion lines. With lighter loads speeds of twelve to sixteen miles per hour have been maintained safely on the rack-rail. These admirable results are due to the great simplicity of all parts of the engines as well as of the superstructure. The traction of the rack-rail being independent of the weather, the service of such roads can be conducted with greatest regularity. Mr. Mutinelli happening to visit the lines in winter time, it is of special interest to observe his remarks on the influence of a heavy snow-fall or snow drifts on the regular operation of rack-rail lines.

The facility with which the Abt rail may be laid and worked in curves, and the steeper gradients which his system admits of being used, must naturally lead to great reductions in the cost of lines through mountainous districts. The labor of the locating engineer will be greatly facilitated. He can approach in a higher degree the ideal, so to speak, of a surface road. A sudden acclivity or descent is cheaply and safely overcome. The flexibility of the system to the exigencies of the ground is well shown on the Harz railway, which, in a total length of seventeen miles, contains no fewer than ten separate, variously distributed rack-rail sections, the smallest of which is but 935 feet in length, while fifty per cent. of the line is laid in curves. The reduction in building expenses has also been strikingly verified on that road. The first $6\frac{7}{10}$ miles were by far the most difficult ones. Before finally deciding upon the Abt system pains-taking field studies and estimates were made by locating different lines, to find out what the difference in cost would be in comparison with a route having adhesion gradients throughout its extent. The relative principal figures which were obtained are so instructive that we give them here from Mr. Evans' paper:

	Abt system.	*Adhesion system.*
Length of line	6.7 miles	9.32 miles.
Real estate required	1,280,000 sq. ft.	1,780,000 sq. ft.
Excavation(earth and rock)	330,000 cub. yds.	1,120,000 cu.yds
Masonry (retaining-walls)	5,610 cub. yds.	33,900 cu.yds

Those construction accounts which differed for the two systems were as follows:

	Abt system.	*Adhesion system.*
Acquisition of real estate	$ 11875	$ 16500
Earthwork, rock, etc	113825	308668
Retaining walls	16125	97125
Copings	20424	38845
Bridges and culverts	2704	5414
Superstructure, rails, ties	97504	97500
Signals and telegraphs	405	562
	$262862	$564611

The Abt system resulted therefore, for that section in a total saving of $301,749. These $6\frac{7}{10}$ miles include 3.22 miles of rack-rail divisions, and it can consequently be said that *for every mile of rack-rail put there on the ground* 301,749 ÷ 3.22 *or over* $93,000 *were saved in the cost of construction.*

Such results are worth looking into, especially as the lines which have been, and which are being built, represent an invested capital of several millions of dollars.

In these days of industrial activity and the rapid development of natural resources throughout our vast territory it is a very important matter to watch carefully the improvements which go on in railway engineering, that one branch of our profession which is so closely associated with our prosperity. Thanks to the generosity of our people and the skill of our engineers, we have to-day those important national highways which unite the eastern and the western slopes of the country, and enormous as the expense has been in cutting through the ranges of the great divide, the significance of the lines amply deserved the liberal assistance of the government. But the ground work has only been laid; the main arteries are merely pulsating; every year adds new sections of the country which require new lines, branch roads, or ramifications from the main system. And this work is entirely left to private means. In such cases capital can only be attracted if the road is going to pay. Economy in construction and strictest economy in operation are the leading objects to be looked after, and here with the hundreds of miles yet to be located in our mountain regions, be it a desirable connection in the White Mountains, a long-talked-of road through the Adirondacks, or lines to and in the mining centres of the west and south, this Abt system of railway with its economy, the rapidity with which lines may be finished and put into operation, appears to us as a most welcome assistance. But lines also which at one time under the strain of necessity had to be constructed with steep adhesion gradients, and which now have to labor under heavy working expenses or which find it difficult to handle their increased traffic, will unquestionably derive great benefit by this expedient of the Abt rail and the Abt locomotives. Increased capacity, safety and regularity will be the result.

The Erie Canal Enlargement.

The Executive Committee of the Union for the Improvement of the Canals of the State of New York have published and are distributing a letter from ex-State Engineer Seymour entitled "The Canal Age. How Shall the Erie Canal be Improved?" in which the honorable writer after showing that at the commencement of this century, the city of New York was only abreast of Baltimore, and 20,000 behind Philadelphia, reviews the building of the Erie canal with nine lateral canals, which developed all portions of the state, besides which she has contributed $12,365,700 to various railroad enterprises, thus early commencing it may be observed, an intelligent system of public improvements which have increased its population from 1,372,111 in 1820 to 5,082,871 in 1880, and have made its seaward port, if we include both foreign, coasting and river tonnage, the first port in the world, besides allowing it to collect, according to the writer, as tolls on the Erie canal $41,903,899.59 more than the total cost of the canal, its enlargement and maintenance up to 1880, and this large sum, of over $118,000,000 was, to a considerable extent, paid as tolls on the produce of other states and Canada, while at the same time the freight paid was enriching the boatmen of the state, who again, according to the estimate of Mr. Seymour, distribute $7,000,000 per year among the farmers and merchants on the line of the canal in payments for fuel, groceries and provisions, besides the further advantage to them which is afforded by the concentration of towns and cities along its line. It may well be doubted if patriotic services ever gave a greater financial recompense than those of Clinton, Morris and the far-seeing and liberal-minded statesmen that associated with them in pushing "the Clinton Ditch" to completion.

The letter summarises the information as to lengths of waterways contained in our review of Sir Charles Hartley's "Inland Navigations of Europe," (Engineering News, February 6, 1886), mentioning in addition to the various projected canals the fact that it is proposed to give the lake commerce 20 feet of water, and asserts that deepening the lock of the St. Mary's Falls canal from 12½ to 16 feet has saved to the port of Marquette alone, within four years, the sum of $3,853.401, or more than three times the cost of the work. All of the above considerations in connection with the proposed speedy completion of the Canadian canals to 14 feet in depth with the lowering of the tolls from 18 and 13 to 2 cents per ton on both through and local freights and the dredging of the St. Lawrence below Montreal to 27½ feet in depth, would, to the mind of many persons, constitute a very strong argument in favor of continuing the proposed 20 feet depth of water throughout the lakes to a connection with the same depth of water in the Hudson.

But the mind of the ex-State Engineer does not work that way; both he, and apparently the "Executive Committee of the Union for the Improvement of the Canals of the State of New York," think "the present boat is as deep as can be made with safety. If the sides were made higher, then, in order to insure stability the boat must be made wider." Mr. Seymour writes, "I have no special interest in any method" (of deepening the canal), "I take an interest in the plan of deepening the canal because the boatmen are in favor of it." "The present boat is as large as can be handled, or constructed with economy"!!! His lack of interest in any special method keeps him from advocating any plan, though it is suggested that there be at least 2 feet of water under the boat, and of the length of the locks "so as to admit of the passage of a steamer and consort at once, it would be a great saving of time."

New locks are referred to as a work of great expense. The question of expense should always attract the Engineer's attention and if there is no promised return for proposed expenditure, the expense may be considered prohibitory whether it is great or small. The records of the Canal Auditor show that the tolls on freight of "this and other states" going from and arriving at tide water for the ten years ending 1869 (before the reduction of tolls) averaged $4,112,633 per annum, which capitalized at three per cent., a rate of interest sufficient for either the State or Nation to borrow on, would amount to over $137,000,000. This was the value of the small canal to "this and other States" for the ten years ending fifteen years ago, before the reduction and subsequent abolition of tolls. There is no formula showing the increased value of the larger canals, but the freighting capacities of boats varying as the cubes of the depths between a 6 and a 20 foot depth would be 216 8,000 or as 1:37, and taking these facts in connection with the great growth of the country tributary to the Erie canal since 1870 it does not seem as if any reasonable expense for the enlargement of the canal would go unrewarded by traffic. As we have pointed out there is a supposed interest in the transfer of freight at Buffalo, and there are doubtless railroad managers who do not care to encounter the change in their traffic that would accompany cheaper water transportation, as, till the increased development from the cheaper freights, their net earnings would be

reduced; these know that there are two methods of defeating a project, one by attacking or opposing it, the other by joining, and changing its direction or so modifying it as to render it worthless or impossible. How far the letter of ex-State Engineer Seymour, circulated by "The Executive Committee of the Union forthe Improvement of the Canals of the State of New York," will influence any enlargement of the Erie canal that is commensurate either with the volume of transportation and wealth of our country or with the necessity for cheaply marketing our wheat, can be seen from the extracts given above.

DeLesseps' Report on the Panama Canal.

When an enterprise has reached the stage where it finds itself with its capital nearly exhausted and all that it can borrow of its friends likewise sunk, and is forced to base an appeal for further loans on an exhibit of its past progress, present standing and future prospects,—one would naturally expect to find in a report of the company's President some facts which would shed a little light on these three things. But for a report that contains the minimum of information, at a critical period of the company's affairs, commend us to the one made to the French Academy of Sciences, on the 27th of March, by M. de Lesseps, after his official visit to the works of the Panama Canal in company with delegates from European and American cities. For some reason the official publication was not made until April 14,and has been only recently received.

De Lesseps begins by saying that he promised to be back in sixty days to tell the results of his voyage and the condition of the works on the Inter-Oceanic canal, and that he has kept his word to a day. He presents the Academy with a map on which is marked the whole course of the canal, with the varieties of soil shown by different colors. One would suppose that such a map might have been submitted five years ago. He then proceeds:

> When I first went to the Isthmus of Panama it was impossible to cross it except by the railway, unless one were preceded by a batallion of negroes, cutting the way with axles through the virgin forest in masses of impenetrable lianas. This is all now completely changed. A broad roadway has been cut from ocean to ocean. In place of trees are workshops. All along the line of the canal there are the barracks of workmen and an uninterrupted succession of dwellings, shops, forges, etc.

We therefore learn that, in the space of time just referred to, the line has been cleared and the work set on foot.

He remarks that the sanitary condition of the isthmus is satisfactory, that the rules of hygiene have been well observed, and that there are but few sick in the various hospitals, of which they have one with 500 beds at Panama. He gives no figures as to the rate of mortality or amount of sickness among the engineering staff and workmen, but simply says, in reference to his short visit of inspection, that no member of his own party, which consisted of thirty persons, suffered the slightest indisposition, "notwithstanding the frequent fatigue of our excursions, under a fiery sum, in a climate which does not resemble that of France."

We now come to the account of the work of construction and find that he saw a mine fired, doubtless prepared for the occasion and described by him as follows:

> We were present at one very interesting thing: the explosion of an enormous mine in a mountain of hard rock nearly 100 feet high, at Gamboa, a point situated almost in the middle of the isthmus. This hill crossed the bed of the canal. It was necessary to make it disappear. Last year, near the same place, a similar operation threw up 20,000 cubic metres of rock. This year, the explosion broke up a mass of 30,000 cubic metres My companions and I took a post three or four hundred metres from the mine. At a signal we saw the mountain rise and crumble, and the smoke swept away, as from a real crater, while fragments of rock, varying in size from pebbles, to blocks of 100 cubic metres, were thrown in every direction. This explosion does great credit to our engineers. That it need not throw the debris too far, and thus injure the neighboring work, they used a mixture of two parts of dynamite and one of powder. I lay before the Academy a drawing, representing the operation as we saw it, with a memorandum from our engineer, M. Bunau-Varilla, on the construction of the mine and the results obtained. I picked up a piece of the rock of which I had made the little cube which I have here, and which I have the honor to present to the Academy. This little cube represents one milliardth part of the mass of porphyry which was thrown up.

There is no doubt but that this mine was well planned and was very effective,—indeed we have already given a description of it on page 303, of our issue for May 8th,—but when we find that there is no other statement of work done in the whole report, and realize that the quality of rock blown out would all be compressed in a cube of 100 feet on a side, it seems a very small matter to stand alone as a representative of the work of five years.

He adds complacently that the work is advancing perfectly on the whole line of the canal from Colon to Panama, and that the completion of the canal is sure on the date fixed in 1888, by the aid of the methods which he has adopted. We look in vain for a statement of monthly output; amount already excavated or what remains to be dug; nothing is said about the great dam or the lateral channels; and we are forced to conclude that little that is favorable can be said in regard to the progress of the work, and that the dark accounts of mismanagement, extravagance and inefficiency which are continually coming through unofficial channels must be founded on truth.

De Lesseps's Veracity Impeached.

PARIS, May 19.—M. Rousseau, the delegate appointed by the Government to inspect the work on the Panama canal, has presented a report in which he denies the correctness of the canal company's statements respecting its facilities for construction, the time when the canal will be completed, and the amount of money still required to accomplish the work. M. Baihaut, the Minister of Public Works, will inform M. de Lesseps and his fellow-Directors that they must reply to M. Rousseau's report, as the Government cannot authorize the proposed issue of lottery bonds until the position of the company is made clear.

Omaha, Neb., Sixteenth Street Viaduct.

(Illustrated.)

Omaha is to build two viaducts this year one on Eleventh street of iron, and one upon Sixeenth street of wood and iron. The latter is herewith illustrated, and was estimated to cost $30,000 against $80,000, the cost of the iron viaduct of Eleventh street, the city feeling unable to build both of iron.

The roadway will decline as shown 3 feet in 100 from each end to Mason street.

The total width of bridge is 32 feet, 6 feet on each side of a 20 foot roadway for teams. It has been the intention for street cars to run on these viaducts but if they are, only one track will probably be put upon them. The Howe trusses are of the ordinary type. The chords of the 50 feet trusses are of three 6 by 12 inch pieces. Vertical posts are 8 by 10 inches and tension rods as shown. Iron to have a tensile strength of 50,000 pounds per square inch, and not to have a permanent set under a load of 25,000 pounds. Herewith is a list of the bids as received by the Board of Public Works May 1st:

F. Wienhagen	$29,950.00
King Bridge & Iron Co	29,100.00
Albert H. Wolf	23,990.00
Chicago Forge & Bolt Co	33,450.00
Morse Bridge Co.	30,377.00
Wrought-Iron Bridge. Co., (Canton, O.)	29,300.00
Missouri Valley Bridge Co	31,500.00
C. A. Hubbard	31,990.00
Raymond & Campbell	28,400.00

The contract has been awarded to Raymond & Campbell of Omaha.

MR. ANDREW ROSEWATER, City Engineer of Omaha, to whom we are indebted for drawings, has had entire charge of the designing of the viaduct.

Elsewhere we publish the specifications.

Traffic Development and the Improvement of the Kanawha River.

In 1873, measures were taken with a view to affording a certain regular and reliable outlet for the coal, salt and other heavy products of the valley of the great Kanawha.

The scheme of course met with opposition from those who readily showed that the commerce of the region was small, the inhabitants poor, the navigation of the river in its then condition precarious and the cost of the improvement large. It was also pointed out that the near completion of a parallel railroad would make the proposed improvement worthless, as it was well known that water transportation had become effete and could not compete with railroads. All of this was successful in reducing the determined depth from the proposed 7 feet to 6 feet, that is, reducing the value of the improvement but not stopping it.

The work has from its inception been under the charge of Colonel W. P. Craighill, and so far one fixed and two movable dams with locks are in operation, with two other locks and dams under way. The effect on the development of that valley is briefly stated by Colonel Craighill "As the improvement of the river has progressed, the commerce on it, notably the shipment of coal, has greatly increased. This has not been to the disadvantage of the Chesapeake and Ohio Railroad, as some supposed would be the case, for the statistics show an increase in the coal business of that highway of trade and travel; the full advantages of the improvement cannot be realized until it be complete."

The following statistics proving the Colonel's position, are given of the movement of coal by rail and river for the years as below, the amounts for 1882 not appearing.

	RAIL.	RIVER.	TOTAL BUSHELS.
1881	6,631,660	9,628,696	12,260,356
1883	13,290,255	15,370,458	28,660,713
1884	12,059,172	18,421,084	30,048,256
1885	12,972,217	17,812,323	30,784,540

The decrease of river coal in 1885 is due to the fact that there were only eighty-three days when there was water enough below Charleston to ship coal, but if the Kanawha had been slackwatered to its junction with the Ohio, coal could have been shipped on 180 days.

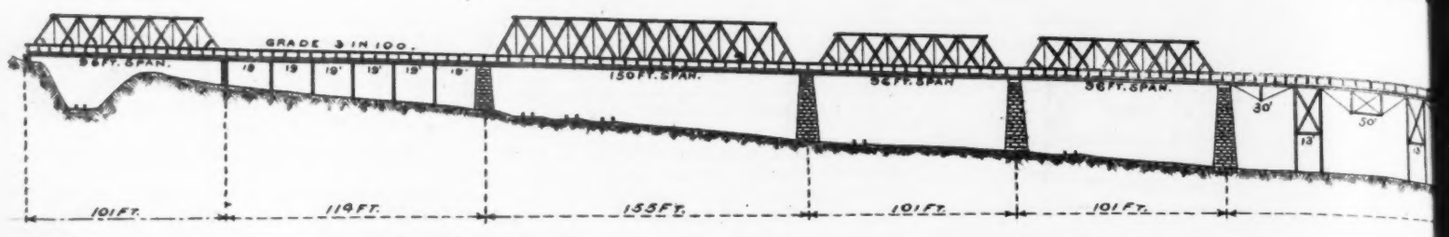
It is a matter of regret that the cost of freight to the producers is not also given; that it has fallen, may be inferred from a late announcement of the Chesapeake and Ohio that they are now transporting coal at $4\frac{47}{100}$ mills per ton mile.

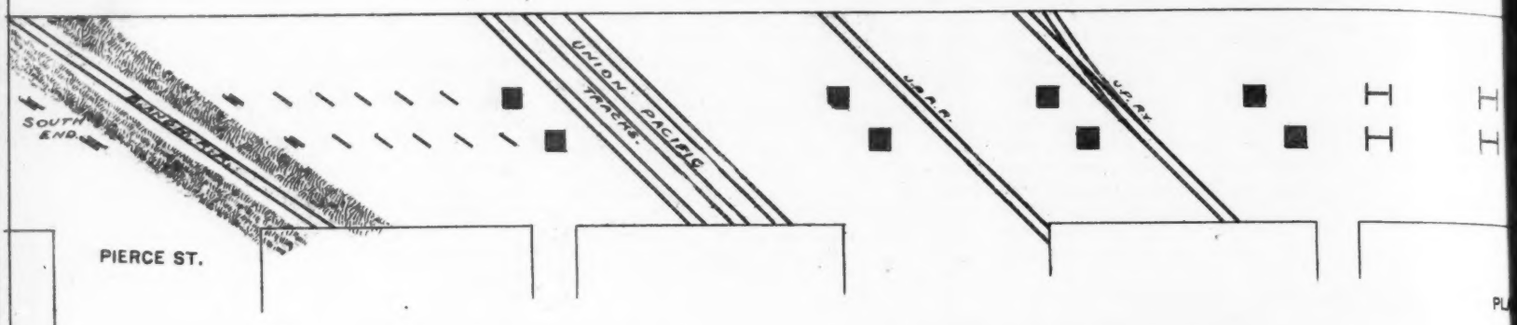
If the engineers in charge of our river and harbor improvements habitually gathered full statistics of the commerce and manufacturers influenced by their works there would be less ignorant, but often honest opposition to their plans, and the fervid patriotism of those statesmen who, gathered at Utica to influence the improvement of our canal, decided that Government aid should not be asked, as other localities might thereby secure some improvement, would be less frequently exhibited.

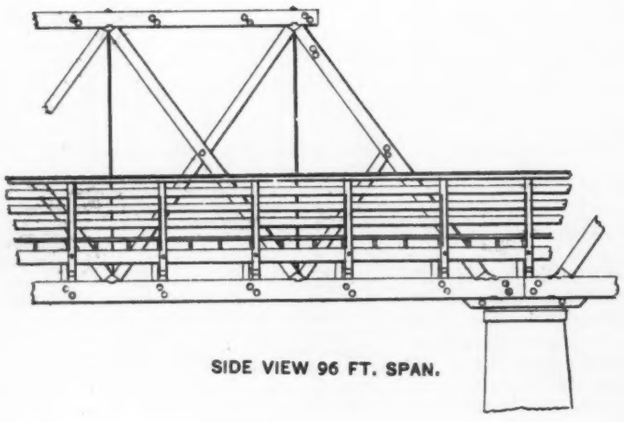
SIXTEENTH STREET

DESIGNED BY ANDREW ROSEW

(For Descr







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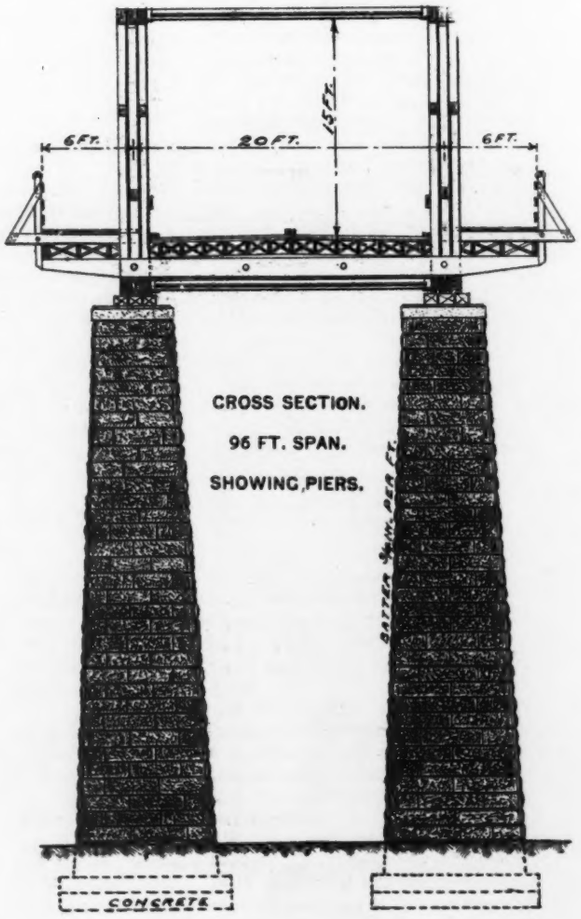
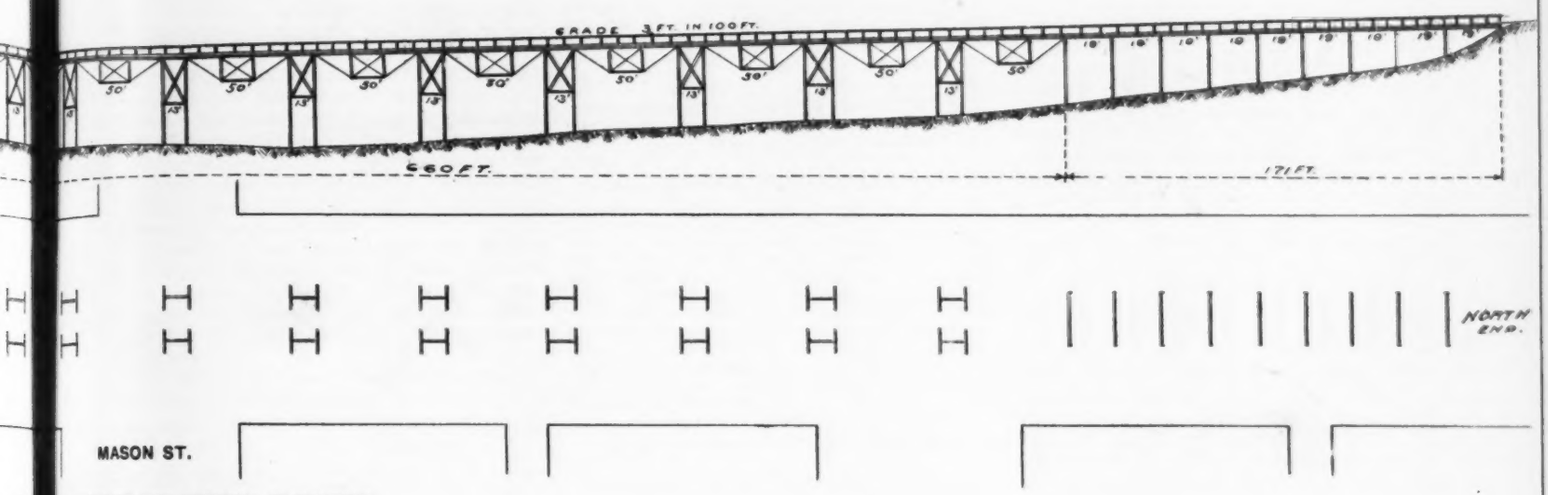


CROSS SECTION.
96 FT. SPAN.
SHOWING PIERS.

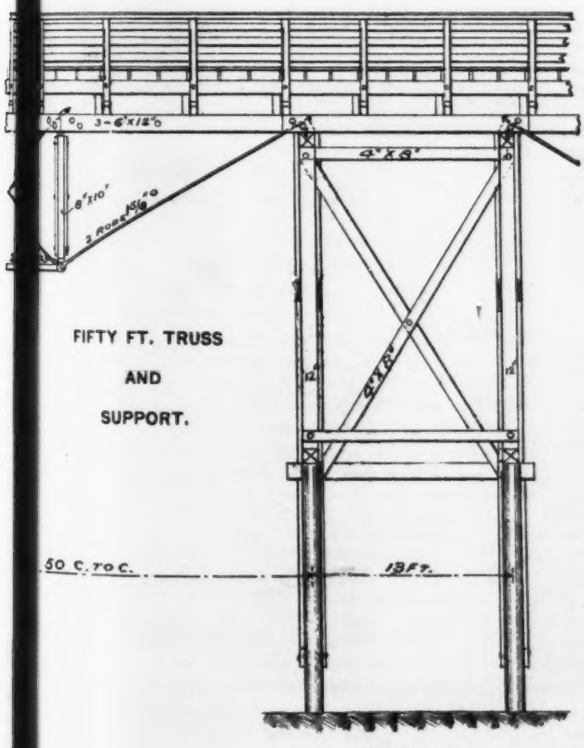
DUCT, OMAHA, NEB.

M. SOC. C. E., CITY ENGINEER.

(Page 330.)

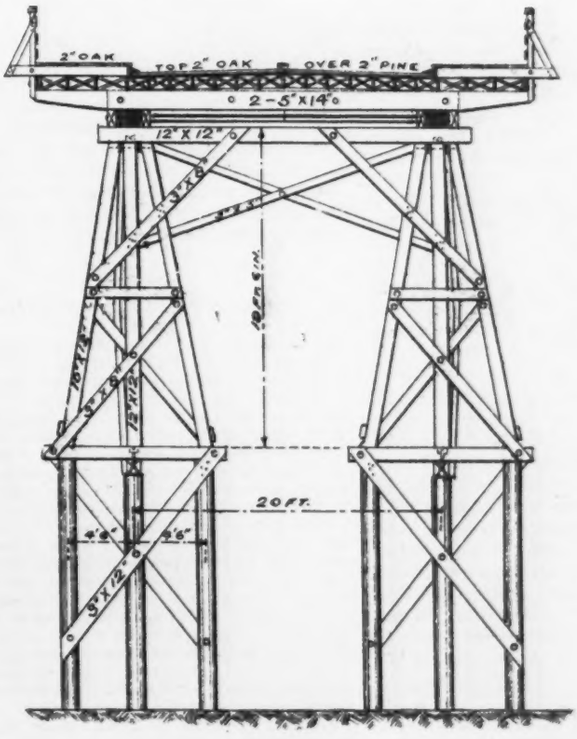


PL UNDATIONS AND GENERAL ELEVATION.



FIFTY FT. TRUSS AND SUPPORT.

SIDE VIEW.



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SIXTEENTH STREET

DESIGNED BY ANDREW ROSEW

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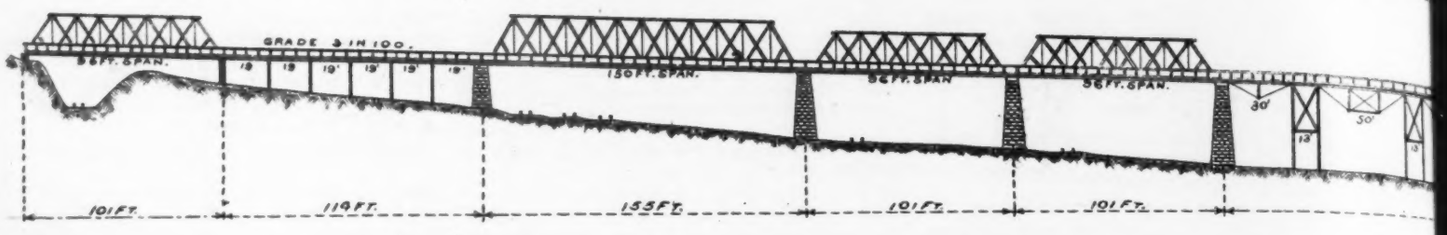

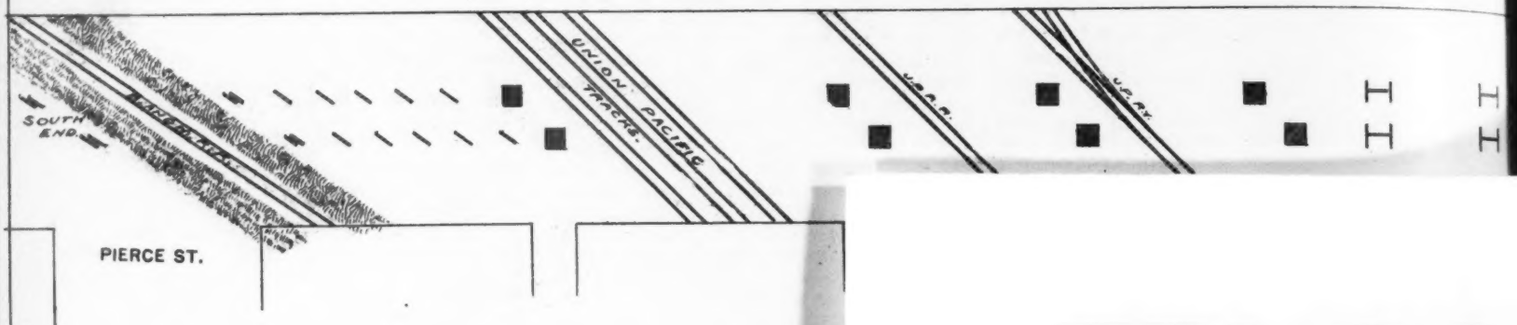

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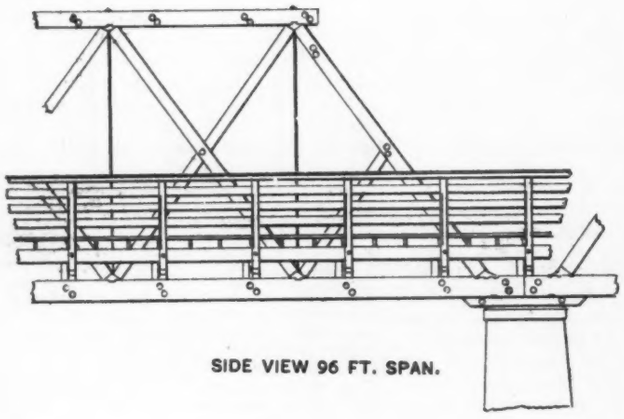

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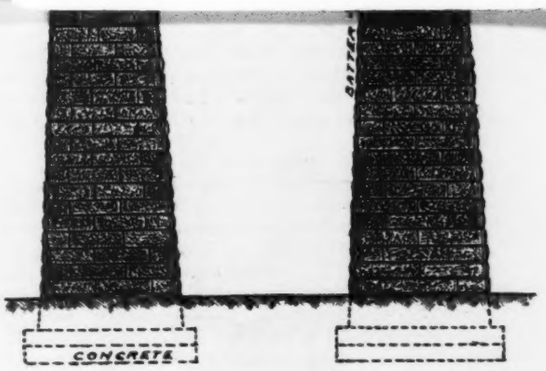

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OSEW M. SOC. C. E., CITY ENGINEER.

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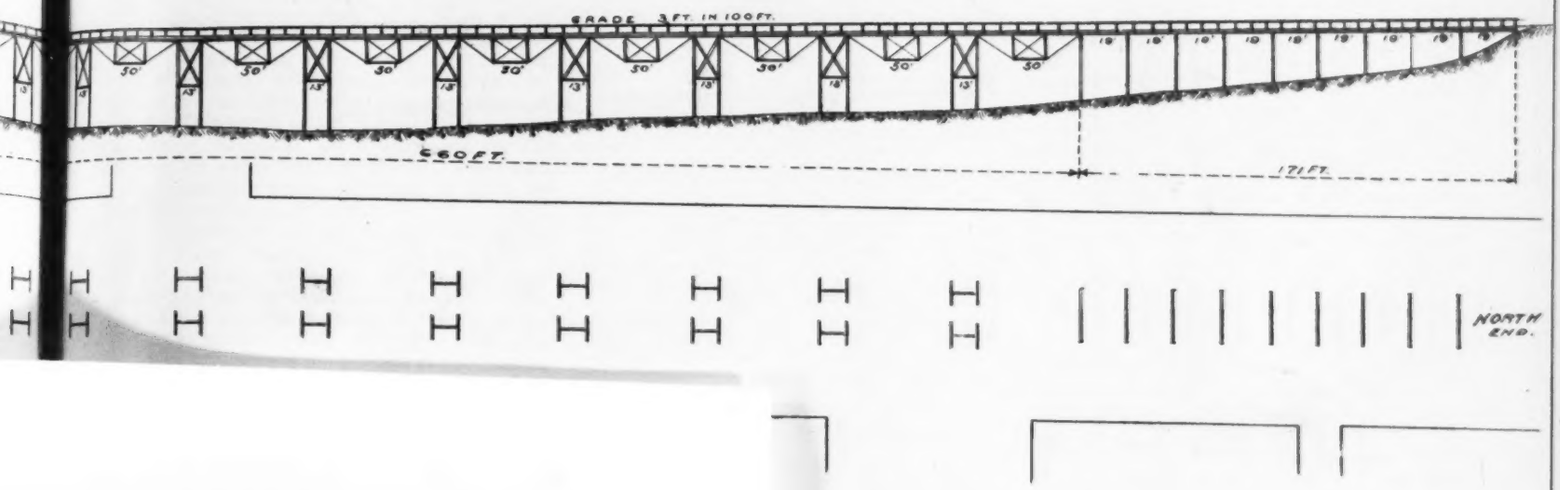

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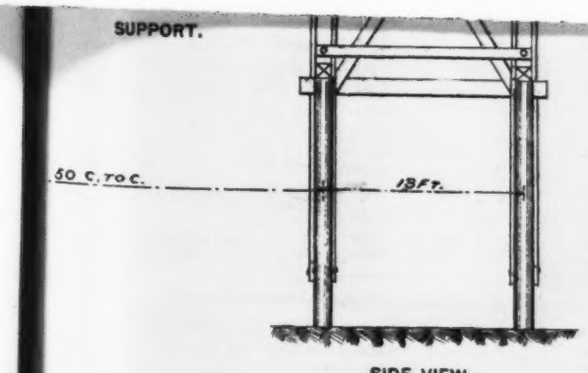

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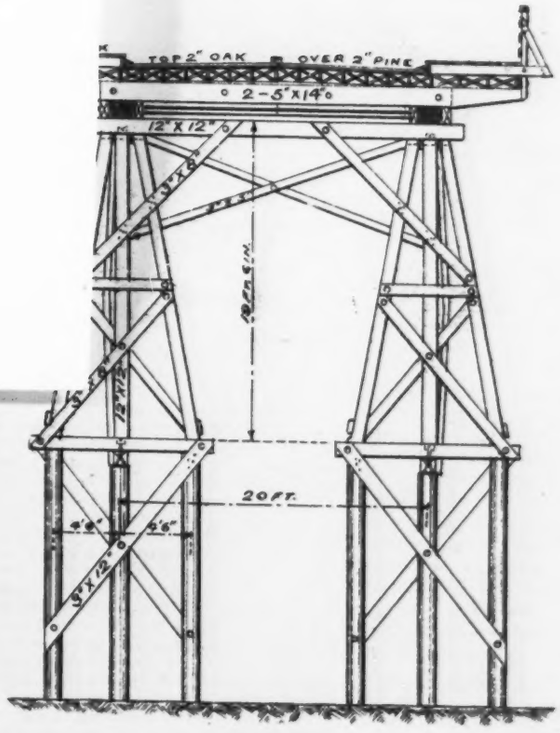

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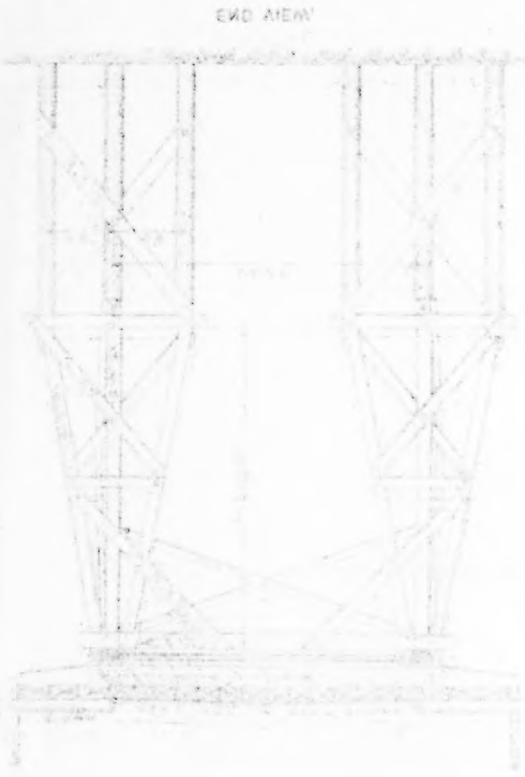


Railroads in India.

The total length of track in operation at the end of March, 1884, was 10,806 miles, and at the same period in 1885, 11,975 miles, an increase of 1,169 miles, of which 989 miles were narrow gauge. The total of 11,975 miles comprised 7,477 miles (of which 858 were double track) on the Indian gauge of 5 feet 6 inches; 4,290 miles, single track, on the metre gauge, and 208 miles, also single track, of narrower gauges. This same total is made up as follows: 4,424 miles belonging to the State (3,028 to the Imperial, and 1,396 to the Provincial Governments); 1,505 miles purchased and operated by the East Indian Railroad Company (468 miles double track); 4,517 miles owned by private companies and guaranteed by the State (390 miles double track); 867 miles owned by subsidized companies, and 662 miles belonging to the native states.

Of the State lines the principal are the Indus Valley Railroad, single track, 5 feet 6 inches gauge, total length, 651 miles; the Punjab Northern Railroad, same gauge, 446 miles, and the Rajputana Railroad, metre gauge, 1,117 miles.

The following is the mileage of the East Indian and guaranteed lines:

Railroad.	Length.		
	Single.	Double.	Total.
East Indian	1,038	467	1,505
Madras	817	42	859
South Indian*	653		653
Great Indian Peninsular	961	324	1,285
Bombay, Baroda & Central India	414	23	437
Scind, Punjab & Delhi	689	2	691
Oude & Rohilkund	594		594
Total	5,165	858	6,023

* Gauge, 1 metre—all the others 5 feet 6 inches.

The mileage of the narrow gauge lines is as follows:

	1 Metre.	4 Feet.	2 ft. 6 in. or less.
Guaranteed lines	653		
Subsidized "	661		59†
State "	2,580	27	63
Native state "	396		59
	4,290	27	181

A total of 4,498 miles.

† 51 miles of this are on a gauge of 2 feet.

There are 1,448 stations and the passenger cars are of four classes. The nationality of the operating staff is as follows: Europeans, 2.06 per cent.; East Indians, 2.15 per cent.; natives, 95.79 per cent.

The following is a table of the locomotives and rolling-stock at the end of 1884:

	5 ft. 6 in. Gauge.	Narrow Gauge.	Total.
Locomotives	1,943	811	2,754
Passenger cars	4,785	2,585	7,370
Freight cars	36,473	14,490	50,963
Total	41,258	17,075	58,333

PERSONAL.

Col. J. T. Fanning, Hydraulic Engineer, is engaged the present season in the preparation of plans for the more complete development of the great water power of St. Anthony Falls on the Mississippi river, at Minneapolis, Minn.

Edw. Barrington has been appointed Division Engineer of the Minnesota & Northwestern R. R., with headquarters at Oelwein, Fayette county, Iowa.

O. M. Shepard has been appointed general superintendent of the New York, New Haven & Hartford R. R., in place of G. M. Reed, who has resigned on account of ill health.

S. H. McElroy has been recommended for appointment as engineer to supervise the work at the new county farm at St. Johnland. Mr. McElroy's father, Mr. Samuel McElroy, prepared the original plans.

Edward Davis, a prosperous railroad contractor, of Chanute, Kan., en route to Grand Island, shot and killed himself in the waiting room in the Union depot at Kansas City, Mo., in the presence of his wife and six small children.

Prof. J. A. Waddell, of Tokio, Japan, was at the meeting of the American Society of Civil Engineers on Wednesday evening. Prof. Waddell will not return to Japan. His present address is Council Bluffs, Iowa.

Arnold Mellert, Chairman of the Mellert Foundry and Machine Company and also of the Reading Foundry Company, died at Reading, Pa., on the 17th inst. Mr. Mellert was born in Germany, June 24th, 1824. He has lived in Reading since 1837, being engaged as boy and man in the iron trade, with every branch of which he was thoroughly conversant. He was also an active participant in the political history of his adopted place, in the Select Council of which he served several terms. In addition to his practical qualities, Mr. Mellert was a good business man of large executive ability and as thorough in administration as in practical details.

American Society of Civil Engineers.

At the meeting on Wednesday evening the paper by Capt. O. E. Michaelis, Corps of Ordnance U. S. A., M. Am. Soc. C. E., postponed from meeting of April 17th, on "A Note of the Cost of Concrete," was read and discussed. The paper by H. V. Hinckley, M. Am. Soc. C. E., on "Errors in Railroad Levels," discussed. The time of the Convention at Denver to meet is changed to July 2nd.

Engineers' Club of Philadelphia.

At the meeting May 1st, Mr. Frederic Graff presented "Notes Upon the Early History of the Employment of Water Power for Supplying Philadelphia with Water, and the Building and Rebuilding of the Fairmount Dam." This is a very interesting paper, and should be read in full by interested parties. It will be published in the transactions of the Society, and can be had by addressing Howard Murphy, Secretary, 1122 Girard street, Philadelphia, Pa.

Liverpool Engineering Society.

The usual fortnightly meeting of this society was held on Wednesday, the 21st ult., at the Royal Institute, Colquitt street; the vice-president in the chair.

A paper by Mr. E. G. Ferber, entitled "Wasting in Marine Boilers" (with some curious instances) was read by the author. The author in the course of his remarks drew attention to the troubles and perplexities of engineers, as well as the expense to owners, caused by the strange freaks of corrosion in marine boilers. He then referred to the recent researches in connection with the anti-corrosive properties of iron v. mild steel, in which it was found that mild steel—the material now coming into general use for boiler construction—was much more liable to corrosion than iron, and stated that in his opinion the anti-corrosive properties, as well as the strength and ductility, of the material ought to be considered in deciding the material to be used in the construction of boilers, as otherwise, in the absence of a means of preventing the corrosion, steel boilers must have shorter lives than iron ones. The author then described several "appliances" and "fluids" now in the market for preventing corrosion, and remarked that, as far as his experience went, their novelty generally exceed their usefulness. The "Electrogen" and "Zinc Slabs" were then treated of, as well as a certain make of "fluid," which had done its work well as a scale preventer, although it had failed to stop the corrosion, which was of a curious and local character.

The "Bower Barff Rustless process" was then referred to, and he instanced several cases in which iron brackets treated by this process had been used in marine boilers, and stated that after twelve months' trial they showed no signs of corrosion, although the stays which were attached to them had suffered slightly. In conclusion, the author described in detail some curious and unaccountable instances of corrosion and wasting in boilers in which none of the appliances referred to in this paper would, in his opinion, have been of any avail in preventing that decay which appears to be inherent to the marine boiler.

Montpelier, Vt., Water Supply.*

Montpelier, Washington county Vermont, in lat. 44° 17′ N. long. 72° 38′ W., is in a valley closely surrounded by hills. Settled in 1787 it was incorporated a village in 1818. The supply of water for domestic purposes, was begun about 1820, by Mr. John Hubbard who laid a line of pump logs from a spring in his pasture about 150 feet above his dwelling and a quarter of a mile distant, first to his own home, and then from time to time extended it to his neighbors. After a time, these logs were lined with lead pipe made in the village, in lengths of 10 or 12 feet and soldered together. The lining was effected by pushing into the wooden pipe a long wire as far as it would go, and then digging down to the end of the line and cutting the log and pulling through the lead pipe attached to the other end of the wire. The lead pipe was 1 inch near the spring and ¾-inch lower down. As the number of takers increased, another line of pipe was added, coming from the opposite side of the village, from three large springs—distant about one mile and at an elevation of over 450 feet—this was a lead pipe, 1¼-inch at the start reducing to 1 inch, and then (after taking off a few branches) to ¾ inch. This line comes across a valley and over a ridge about 100 feet in height before reaching the village. Later, another line was added coming about one-half mile from two springs, with an elevation of a little more than 100 feet—with 1-inch lead pipe reducing to ¾-inch. This line supplies consumers almost from the very beginning and comes down a long hill, with several branches going to houses on the upper side of the street, 30 or 40 feet higher than the main pipe. In 1884 a line of cast-iron pipe was added coming from a very large spring distant one and one-half miles, and at an elevation of 450 feet. The first 1,200 feet after leaving the spring is of 1½-inch pipe weighing five pounds to the foot, and has a fall of 185 feet. The pipe is then enlarged to 2 inches, and in the next 1,450 feet has a fall of 255 feet more—making 440 feet in all—it then crosses a stream and flat for 1,350 feet. In the next 1,200 feet it rises 210 feet and goes over a ridge and down about 30 feet and discharges through an open pipe into a small reservoir. The 2-inch pipe is of three weights according to pressure—six, seven and one-half and nine pound per foot. From the reservoir a 2-inch pipe goes about one-half mile with a fall of 190 feet to the village.

This reservoir is made of stone and cement and is entirely underground, with a manhole in the top. It is partitioned into two compartments, each having a supply, and outlet, and waste pipe. The waste pipes are 2-in. standing or "bath wastes," which can be pulled out to empty the compartment for cleaning strainers or for repairs. There are gate valves on each pipe and one on a pipe through the partition.

The other lines of pipes have no reservoirs.

All of these different lines are brought together in the cellar of the dwelling of the present proprietor, Mr. John E. Hubbard, the grandson of the originator of the works, near the center of the village, and by a curious looking combination of crooked pipes, valves

* No 812. History and Statistics of American Water Works. By J. J. R. Croes, M. Am. Soc. C.E.; M. Inst. C.E.

and stop-cocks they are arranged so that they can be worked together or separately, or in all possible combinations. Here also are five pressure gauges on the different lines, which show at a glance whether all have the proper pressure or whether some line is a little weak and in need of assistance from its stronger brothers. In addition to the pipes above named there are about two miles of street pipes, and a little over two miles of ¾-inch branches. There are about 230 consumers.

The system of supply is by gauged streams which run continuously into some sort of cistern (in many cases a common barrel) which is provided by the water-taker, and furnished with a proper waste pipe. The old style of gauges was a small copper tube (made by drawing sheet copper through a wire plate) about 2 inches long, inserted in a pine plug which had been turned to the proper size to fit the ¾-inch pipe where it came through the cistern. But these plugs were so easily taken out to obtain a larger quantity of water that they gave a great deal of trouble. To meet this difficulty a brass gauge and connection between the cistern and the pipe was designed having a gauge in the end, which cannot be stopped by sediment or anything in the water and which, while it is easily taken off by the proper wrench, has thus far stood proof against all attempts to tamper with it by the consumer. This gauge is not injured by freezing, and when taken off leaves the full size of the pipe open to insert thawing tube or attach force pump. The stream delivered may be of any size, but for an ordinary house the hole through the gauge is not larger than a medium sized sewing needle, which will deliver about 100 gallons per day. The gauge in most case is in the bottom of the cistern.

The water is very pure spring water and contains a small amount of carbonate of lime which speedily forms an insoluble coating on the inside of the pipe, which effectually prevents any action of the water upon the lead.

Nearly all of the springs are built up of bricks and cement from where the spring comes out of the slate stone rock, to about a foot below the level of the ground, then a flat stone is cemented over them and they are covered up with dirt. Such of them as have to be opened occasionally are provided with an iron "man-hole" cover bolted down. Thus the water is secured just as it comes out of the bed rock and is exposed to daylight for the first time, as it boils up in each individual cistern.

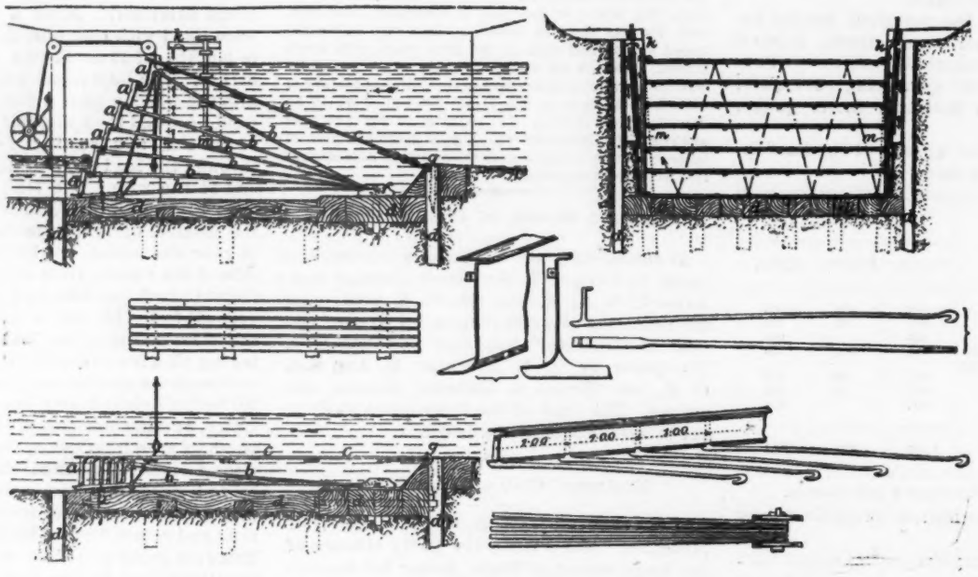
The proprietor considers that the system of supply has many advantages in a cold climate like that of Vermont as the pipes are nearly proof against freezing. It is cheaper than any other on account of the small pipes used. It is stated that a single ¾-inch pipe has supplied satisfactorily over 100 houses. In some cases the cistern is in the attic and supplies an elaborate system of house piping and in others, where cheapness is the main object, a barrel is placed beside the kitchen sink and a pipe led to it which keeps it always full of fresh cold water. The proprietor says, "The locating of leaks in some of these old pipes and the curious results which are obtained when a little air gets into the pipes, might perhaps puzzle engineers who have had a life-long experience in water works on a larger scale."

In 1884, works for a general supply were built by the village, taking the water from a stream flowing from Berlin Pond from which is a natural lake in the hills, covering an area of two miles long by half a mile wide. A mile below the pond, a dam of rubble masonry in cement, 14 feet high and 25 feet long forms a reservoir holding 4,000,000 gallons at 364 feet above the village, to which the water is conveyed by 12-inch cast iron pipe.

Distribution is by 10½ miles of cast iron pipes of 12 to 4-inches diameter, and wrought iron pipes of 2 inches diameter, with 233 taps and 53 fire hydrants. The pressure is 158 pounds.

The cost of the village works has been $66,406 and the bonded debt is $60,000 at 4½ per cent. interest. The expense of maintenance in 1885 was $3,535 and the revenues from water rates $3,325. The interest on the bonds is paid out of the public taxes.

The works are managed by the village bailiffs. The population in 1880 was 1,847.



Automatic Lock Gate.

The Automatic Lock Gate.

M. Czvetkovics, of Esseg, is the inventor of a new lock-gate the principal characteristic of which is its automatic movement under the action of the vertical pressure of water.

This gate, held between two abutments which may be of piles or even steep banks, is made up of a variable number of stop-planks *a* placed one over the other and each as long as the space between the abutments and from 8 to 10 inches wide. They are made up of two or three sections of sheet-iron.

The top and bottom of each stop is bent out at a right-angle forming interlocking ledges which enable each stop to raise the one below it. These stops are worked by the iron rods *b*, of special form, which fold and unfold like a fan around a fixed horizontal axis *f*. A protecting grating *c* made of wood stops any floating material and allows only sand and small gravel to pass it. This grating also turns on a horizontal axis *g*, and rests upon the upper stop plank to which it is sometimes attached; it assists this upper stop-plank in lifting both under the water pressure and by reason of its lightness.

The working of this lock gate is simple and easily understood. When the gate is in position in the bed of a stream the upper stop offers a certain resistance to the current and causes the water to rise. As a result of this change in level the hydrostatic pressure, which is constantly increasing, acts upon the lower flange of the stop and raises it and by reason of the interlocking of these flanges also lifts the next lower stop. The pressure of the water becoming greater constantly raises these stops successively until the very last one is lifted slightly from the sill and a space there left through which a certain portion of the imprisoned water can escape and take with it the sand and gravel which may have accumulated behind the dam.

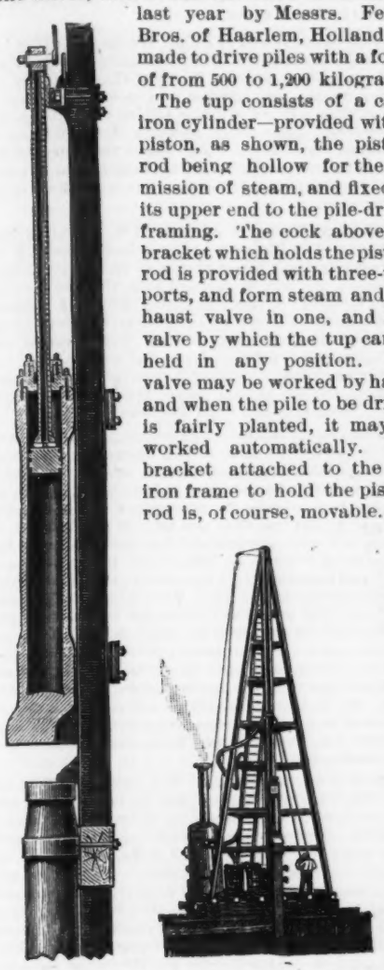
It can readily be seen that the wider the lower flanges of the stops are made the greater will be the concavity of the raised gate and the greater also the lifting power. But at the same time the stops lose more of their absolute weight and it is possible for the water pressure to raise the gate above the surface. To prevent this it it anchored firmly to the bed of the stream by the rods shown just behind the lower stop-plank in such a manner that this can only raise a slight distance above the sill.

The figures show the gate both raised and lowered and the rods and their attachment.—*Le Genie Civil*, March 20, 1886.

The Blackville (S.C.) & Alston R. R. Co. has been organized with D. H. Salley, President, and Directors E. S. Hammond, J. J. Whaley, Nathan Porter, M. Brown, Alfred Aldrich and J. M. Price. The road will be standard gauge, and work will be commenced as soon as possible.

Steam Pile Driver.

The *Genié Civil* describes the accompanying pile-driver, which was exhibited at Antwerp last year by Messrs. Fegee Bros. of Haarlem, Holland, as made to drive piles with a force of from 500 to 1,200 kilograms.



The tup consists of a cast-iron cylinder—provided with a piston, as shown, the piston-rod being hollow for the admission of steam, and fixed at its upper end to the pile-driver framing. The cock above the bracket which holds the piston-rod is provided with three-way ports, and form steam and exhaust valve in one, and also valve by which the tup can be held in any position. The valve may be worked by hand, and when the pile to be driven is fairly planted, it may be worked automatically. The bracket attached to the tee iron frame to hold the piston-rod is, of course, movable.

When is a Bridge not a Bridge?

The fine distinction which Governor Abbett recently drew in his veto message between a bridge and a viaduct calls to mind an historical decision in the New Jersey courts. In the year 1790 the Legislature began to appreciate the need of free communication between the little cluster of houses at the ferry of Powles Hook—which has since that date expanded into Jersey City—and the Commonwealth that lay behind it, and a commission was appointed to contract with enterprising persons who would undertake to bridge the raging Hackensack and Passaic and connect the "Court House at Newark with said Powles Hook." Acting on the discretion granted them the commission gave to Samuel Ogden and thirty-six others, afterwards incorporated as the "Proprietors of the Bridges over the rivers Passaic and Hackensack," the exclusive privilege of building and maintaining said bridges and taking tolls thereon for ninety-nine years. Under State authority these proprietors raised the needed capital by selling lottery tickets and the bridges were built.

At a later day the New Jersey Railroad and Transportation Company bought this franchise, and when in 1860 the Hoboken Land and and Improvement Company obtained a charter for a road connecting the Newark terminus of the Morris and Essex Railroad with Hoboken, the New Jersey Railroad asked the Court of Chancery for an injunction restraining the new company from bridging the rivers and thus infringing on the monopoly they had acquired. The Chancellor denied the injunction on the ground that the structure to be built was not a bridge as the term was understood when the franchise was granted, to wit, a roadway for persons on foot or on horseback or in wagons or sleighs drawn by horses or oxen. The New Jersey Railroad appealed and the Chancellor was sustained in the Court of Errors, in a decision rendered by Judge Vredenburg, who was as full of humor as of law. The learned judge held that nothing was more variable than language, and what might be styled a bridge now was a very different thing from what was in the minds of the legislators of 1790.

The seminal principal of a bridge is a foot-path—all the rest is development. A plank across a brook was a bridge, but take away the plank and the bridge vanished. In a wider stream planks reaching to either bank from a stone in the middle were a bridge, but the stone was not the essence of the bridge, neither were artificial piers in a wider stream, nor abutments, nor railings. The essence of the bridge from the original plank to Trajan's archways across the Danube was the pathway and nothing else. A row of piles across the Hackensack would not be a bridge, but if a series of planks were spiked thereon to form a footway, the structure would be a bridge. A line of iron rails upon the piles would be no bridge—nor would two lines 4 feet 10 inches apart and connected with either shore. A bridge was the continuation of a roadway, with no difference between the two except that one was on solid ground and the other over the water. Broadway would still be a road if a railroad track were laid through it; but it would not be a road if the bottom should fall out and leave nothing but the rails with an unfathomable gulf below. This railroad crossing had none of the essentials of a bridge as known in 1790, and if it had been built then it would have stood unused for a thousand years unless the locomotive had been invented.

True it was called a railroad bridge in a loose and casual manner, but that did not make it a bridge any more than it made a locomotive a horse to call it the steam horse or the iron horse. "Indeed," continued His Honor, "there are many points of similarity between those two swift servants of man. To be sure the one drinks larger draughts of water and his food is coarser. He devours the trees of the forest instead of the grass of the field. His neigh is louder, and his heart as he champs upon the bit is fired by an intenser heat. The breath of his nostrils beclouds his pathway as he shouts his challenge to the sun and holds on his tireless flight to the occido-orient. But he has no feet and his bridge wants no foot-path. The bridge is the congener of the horse and the railway of the locomotive." The sombre pages of the Court Reports are illuminated by a good deal more pictorial language and not a little wit, as when he declares that a telegraph wire is not a bridge although more news is flashed across it in a day than the old couriers used to carry across the Hackensack in a year, announcing from their foaming steeds, "We come the herald of a noisy world! News from all nations!"

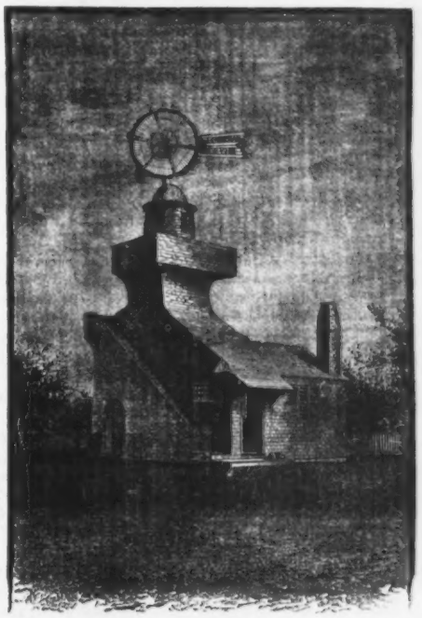
Of course this eloquent decision was affirmed by the Supreme Court of the United States when the case was carried there, and since then New Jersey lawyers are careful to call railway bridges "viaducts."—*N. Y. Tribune.*

PUBLIC trials will be given at Champaign, Ill., June 10th and 11th, under the auspices of the State Board of Agriculture, of machines for opening ditches for drain tile and of machines for the excavation of canals. Two gold medals are offered as prizes.

WATER

WINDMILL AND TANK TOWER.

Erected on the "Meeker Place," Shrewsbury, N. J., for supplying the residence with water.



WINDMILLS for pumping water are not novelties; there are hundreds of them performing this useful duty on as many farms throughout this country. Their application to residences is however somewhat of a novelty, and as a picturesque addition to a village landscape they are unusual. The above cut, representing the application of a Corcoran windmill at a New Jersey summer resort, cannot fail to prove of suggestive interest to parties desirous of obtaining a cheap and abundant supply of water, and at the same time holding sole control of its government.

The tower sustains a large tank or reservoir, containing water sufficient for use during several days. The outfit is one of thirty-five in the immediate neighborhood, and the visitor to Seabright and vicinity, can see these doubly useful and ornamental additions to the beautiful seaside cottages, with which the Jersey coast abounds. One at Seabright supplies fifteen houses with water. Mr. A. J. Corcoran of 71 John street, New York, is the leader in this novel application of the useful old windmill—by him rendered "a thing of beauty and a joy forever"—and he has a handsome catalogue fully illustrating the esthetic and economic features of windmills, which he will send to any address on application.

WATER POWER FOR DENVER.

To the Denver *Tribune-Republican*:

EAGLE ROCK, Idaho, May 8, 1886.

In your issue of May 1st, I notice parties in your city contemplate putting up an undershot water-wheel for the purpose of obtaining power for various purposes. (*see page* 318, *May* 15*th.*) Having just completed one of those wheels for pumping purposes I may be able to give the projectors of the wheel you refer to some valuable information, which I will be pleased to do gratis.

I experienced many difficulties at first not thought of, but by mending every defect as fast as it presented itself, believe I have completed a wheel it will be difficult to improve on. As the parties may meet with difficulties, which are not now apparent, I think it quite likely I may be able to furnish them with hints of some value, and will do so if they refer to me in person or by letter.

I am quite sure this class of water wheels may become of great value throughout the West, and knowing of the complete and partial failure of many of them and the complete success of this one near Eagle Rock and feeling properly constructed wheels of this kind will prove of great value, I will feel pleased to give any one desiring the information the benefit of my experience. You may inform your citizens to that effect. This wheel is adjustable to all stages of water and so arranged that drift wood does not interfere with it, although allowed to pass under it, and is also fixed to run right along at different heights and not interfere with the gearing. As the river you refer to no doubt rises and falls considerably, the ideas adopted and working successfully here may prove of value. Having previous engagements, can only answer questions or show parties how this wheel works. Yours truly,

GEORGE TOLMIE.

THE Seville, Fla., water-works will be in operation shortly.

THE Citizens' Gaslight Company, Rye, N. Y., will erect new gas works.

SHERMAN, TEXAS, is agitating the building of water-works. Plans and estimates are being prepared by A. S. Hayne.

CHITTENANGO, N. Y., is agitating for water-works, and Cazenovia, N. Y., is talking of water-works and sewerage systems.

THE Kankakee Water Company, Watertown, N. Y., will erect water-works at Kankakee. Attorney, H. K. Wheeler.

THE Panther Valley Water Company, Lansford, Pa, Capital stock, $25,000. Treasurer, John E. Lauer Lansford.

GEORGETOWN, COL., May 8th.—Mr. E. Le Neve Foster, civil engineer, is making an elaborate survey of the town for the purpose of making estimates and putting n a new system of water-works.

AUGUSTA, ME., May 10th.—At a general meeting of citizens this afternoon, it was voted by a majority of 365 to instruct the city council to make a contract with the Augusta Water Company for building a fire system. The total vote cast was 1297.

J. M. LOWE, representing a water-works firm of New York, has asked the North Plainfield, N. J., Council for permission to lay before that body plans and specifications for a system of water-works in the borough. This, with a similar petition from Samuel R. Bullock & Co., of New York, was referred to the Committee on Fire, Water and Lamps.

THE Ellsworth, Me., Water Company made up wholly of Ellsworth citizens, has made a proposition to furnish the city with water for fire and other service. The new company proposes to take water from Branch Pond stream, carry it all over the city, including the Falls village, furnish the requisite number of hydrants, also furnish drinking fountains, one ornamental fountain, and the schools and public buildings with water without extra charge.

TAUNTON, MASS.—The Water Commissioners have at last awakened to the fact that the cause of the "cucumber" taste so apparent in the city water for several summer seasons past is caused by the open filter basin. The Commissioners have asked for $10,000 with which to construct a brick covering for the basin, in order to exclude the air and heat, and thus to make a subterranean conduit of it. It is probab'e that, before any extensive outlay is allowed, experiments will be made with a wooden and canvas covering.

AUGUSTA, ME., May 17th.—The city government this evening completed the contract with the Augusta Water Company to furnish a fire service for the city with a sufficient number of hydrants and to supply water for all other purposes, required by the city for an average sum of $2,000 per year for the first twenty years, and the twenty years following $1,000, the water to be taken from the Kennebec river to a reservoir 269 feet above the level of the river and with a capacity of 6,000,000 gallons. There will be fourteen miles of pipes, including all sizes. Water power will be employed for pumping, and arrangements will be made so that the pump pressure can be placed on the pipes when required. The annual rental to families not exceeding six persons is not to be ocer $8.

WASHINGTON, D. C., May 3.—The House Committee of Public Lands has somewhat modified the Senate bill granting the right of way through the public lands for irrigation purposes. In addition to allowing the right of way for the building of canals and ditches for the purpose of irrigation, they also include "drainage and other purpos s," and they also have added the following provision thereto: "That nothing herein contained shall be construed to abridge the power of any State or Territory to control by law the use of water for the benefit of other corporations or citizens, nor to confer on any corporation or citizen the title of any waters to be carried by said ditches or canals, a right of way only being hereby granted."

AT a meeting of the East Orange Sewage and Drainage Committee held May 17th, C. P. Bassett, of Newark, was engaged to prepare complete plans of a sewerage system for the township, with details of a local purification process, and prepare the work for construction. East Orange being refused permission to connect with Newark's sewers, and finding a line to the bay enormously expensive, if not impracticable, has decided—in view of the pressing ne essity for sewerage—to purify the sewage locally, and have placed the work in Mr. Bassett's hands he having originally advocated this process. The system of purification will be novel in this country, the difficulties having been worked out among the denser population of Europe. Mr. Rudolph Hering, of Philadelphia, will act as consulting engineer.

HOMESTEAD, PA., is agitated over a propostiion to erect water-works, and a special committee of Councils, consisting of August Hirth, M. P. Schooley, L. L. Davis, Borough Solici'or, and W. F. Bullock, are now on a tour of inspection. They will visit Altoona, Latrobe, Greensburg and Connelsville before they return.

PRICE OF GAS IN NEW YORK.—Governor Hill has signed two bills relating to the price of gas in this city. One called the Reilly Bill is as follows:

SEC. 1. In cities having a population of 800,000 and over, no corporation or person shall charge for illuminating gas a sum to exceed $1.25 per 1,000 cubic feet.

SEC. 2. The illuminating gas furnished by any such corporation or person shall have an illuminating power of not less than twenty sperm candles of six to the pound, and burning at the rate of 120 grains of spermaceti per hour, tested at a distance of not less than one mile from the place of manufacture, by a burner consuming 5 cubic feet of gas per hour, and shall, as regards purity, comply with the standard now or hereafter established by law.

SEC. 3. All acts and parts of acts inconsistent with this act are hereby repealed.

SEC. 4. This act shall take effect immediately.

The other, called the Thomas Bill applies only to companies formed after April 1, 1886. It was drawn with great care, and is full of safe-guards that will prevent any company formed under it from consolidating or combining with any other company. It fixes the price at a sum not exceeding $1.25, and the dividends at a rate not exceeding 10 per cent. on the cash capital actually paid in, although an additional dividend of 1 per cent. will be allowed for each reduction of five cents in the price.

LEE DAM DISASTER VERDICT.—PITTSFIELD, MASS., May 12.—Judge Branning of the Lee Police Court, before whom the inquest as to the cause of the death of the persons who lost their lives by the bursting of the East Lee reservoir was held, filed his verdict this forenoon. He says they came to their death by drowning in a flood caused by the bursting of the reservoir, and after a lengthy review of the testimony taken at the inquest, concludes as follows:

"None but the wisdom of Omniscience can certainly know the cause of the dam's breaking from its lonely mountain home and resting place, to deluge and destroy a devoted little village at its feet. It was testified that repeated statements of apprehension on the part of different individuals as to the safety of the dam, to some of the owners were regarded in the light of unfriendly criticism rather than from any real apprehension or fear worthy of serious consideration. Yet the event has proved that their fears as to the safety of the dam were well founded. In view, however, of all the testimony given at the inquest, it does not appear to this court that there has been such culpable negligence in the regard to the dam by its owners, or any of them, as to require further proceedings in the premises."

Notwithstanding that the verdict seems to exonerate everybody supposed to be responsible, it is known that one or two suits for damages are in the hands of counsel to be prosecuted unless the claims are otherwise settled.

NEWS OF THE WEEK.

Railroads, Bridges and Canals.

The Rockport & Limerick R. R. Co. has been incorporated at Portland, Me.

Covington & Cincinnati Bridge.—In the Senate the House bill has been passed authorizing the construction of this bridge across the Ohio river.

Land Survey.—Surveyor-General Dawson has advertised for bids for the survey of the lands included in the old White River Military Reservation in Garfield county, Col.

The Lancaster & Hamden R. R. Co. has been organized to build a railroad from Hamden, O., on the Cincinnati, Washington & Baltimore R. R., to Lancaster, a distance ot about fifty miles.

The Sprague Electric Motor.—A very satisfactory run was made recently with this motor on the Thirty-fourth street branch of the Third Avenue Elevated Railway.

The Memphis & Southeastern R. R. Co. has been incorporated in Tennessee, to build a road from Memphis to the Mississippi State line, to connect with the Kansas City, Memphis & Birmingham R. R.

The Pennsylvania Railroad is making a small experiment in iron ties by laying about two miles of them on the main line in the Philadelphia yard. They are of inverted channel-bar section and are made by the New Jersey Steel and Iron Company, of Trenton.

A West Kansas R. R.—E. R. Shuable, of Garden City, Kan., is about to locate a north and south railroad between the Atchison, Topeka & Sante Fé R. R., and the Union Pacific R. R., there being a big land excitement in West Kansas.

Cincinnati Board of Public Works.—The Ohio Legislature has passed a bill abolishing the Board of Public Works and the Board of Health of Cincinnati city and authorizing Gov. Foraker to appoint five citizens to constitute a Board of Public Affairs, whose duties shall comprise those which formerly devolved upon the boards. Gov. Foraker has made the appointments, and the Board of Public Works has resolved to contest the legal existence of this board by proceedings in quo warranto.

Chicago, Kansas & Nebraska R.R.—ATCHISON, Kan., May 14.—The Directors of the Chicago, Kansas & Nebraska Railroad, better known as the Rock Island, in Kansas, met here to-day, and authorized the execution of a mortgage on their projected Kansas & Nebraska extensions to secure a loan of $10,000,000, recently subscribed in New York. Among those present were Messrs. Cable, Kimball, Lowe and Parker. The company has leased a building in this city for the general offices, and has already located here its Auditor, Secretary, Treasurer and Chief Engineer.

Lake Street Bridge.—The iron swing bridge over the Chicago river at Lake street, Chicago, is completed, but the viaduct and approaches are not yet finished. The bridge is 220 feet long, 23 feet high in center, and 20 feet high at ends; it has a width of 60 feet, composed of two 21-feet roadways and two 7-feet sidewalks: the floor will carry a weight of 125 pounds per square foot. The drum on which the bridge turns is 48 feet in diameter, and rests on 74 solid iron wheels, 18 inches diameter and 8 inches wide on face; the gearing is of phosphor bronze. The bridge will be turned by a steam engine with a pair of 8-in. by 12 in. cylinders, and a 7-inch cylinder engine will be used to drive the electric light plant: the engine-house is on top of the structure. The bridge will cost $145,000, divided equally between the city and the West Division Street R. R. Co.: the viaduct will cost $55,000, paid by the railroads interested; total cost, $200,000. Work was commenced in November last.

New York Legislature.—The Assembly has passed the following bills: authorizing the new aqueduct commissioners to appoint special policemen to preserve order on the line of construction; appropriating $15,000 for improving the state dyke at East Greenbush, and providing that any street surface horse railroad may, by consent of one-half of the property owners, convert their line to the cable system. The Senate has passed the following bills: prohibiting elevated roads on certain Brooklyn streets; permitting short mountain railroads to charge 7 cents per 100 feet of elevation; permitting the Kanona & Prattsburg R. R. to use 40-pound rails; Niagara Hydraulic Tunnel Co. amendment; Brooklyn park commission; Amsterdam sewer, and Callicoon bridge. The following bills have received the Governor's sanction: appropriating $2,500 for repairing banks at Glen creek; providing for a supply of water for fire purposes in Waterford; for drainage of Ballston Spa; for lift bridge over the Champlain canal in Mechanicville; for winding up the Broadway Railway Co.; for extending the powers of the Syracuse Water Co., and authorizing the issue of additional bonds; for road improvements in Middletown; amending map of 23rd Ward, New York City; legalizing the Saugerties and Woodstock Turnpike and Tramway Co.; for care of bridges over Byron river between Westchester county and State of Connecticut; providing for payments of claims growing out of the construction of the Amsterdam water-works, and the New York aqueduct bill.

CONTRACTING.

Pig Iron.—The Grand Trunk R. R. Company advertises for proposals for 2,000 tons of best quality charcoal pig iron, suitable for the manufacture of car wheels. The iron must be close grained, and chill one-half inch; must analyze about .30 in phosphorus, and not exceed .12 in manganese and .02 in sulphur, and contain at least four per centum combined, and graphitic carbon; must show from a test bar, 1 foot long and 1 inch square, a transverse strength of 3,500 pounds.

Bridges.—Bids will be received until June 21st, at the office of the County Clerk at Clay Center, Nebraska, for the erection of twenty, more or less, bent bridges, the same to be built at such times and places as the county commissioners of Clay county, Neb., may order; all bids to be by the linear foot. The bridges are to be constructed as follows: posts and sills of 8-inch by 8-inch oak; roadways 14 feet wide, planked with 2-inch oak planks laid diagonally, and bolted to each cap with 2½-inch bolts; stringers 3-inch by 12 inch pine, laid 12 inches center to center; caps, 8-inch by 8-inch pine; handrails, 4-inch by 4-inch pine, dressed and painted; ends of bridge to be planked with 2-inch planks from mudsill to top of roadway.

Council Grove, Osage City & Ottawa R.R.—Messrs. Prisco & Montani have closed a contract for the construction of this road. Work began on the 20th from Ottawa, Kan.

Kansas State House.—The commissioners have awarded the contract for masonry of interior walls to Bricker & Evans, Topeka, for $25,550, and for ironwork to the Missouri Valley Bridge Co., Leavenworth, for $8,485. The contract for the exterior walls had already been awarded to Cuthbert & Co. Work on the walls of the first story to be completed by December.

Sewers.—The following proposals have been received for constructing sewers in Brooklyn: *Vernon avenue*; Thomas Newman, 12-inch cement pipe, per running foot, $1.10: manholes, each, $40; street basins, each, $95. Charles Hart, $1.09, $36, $109. William Mogk, $1.29, $36, $99. Edward Gorman, $1.07, $37, $100. John Bray, 90c. $37, $100' *Prospect Place*; John Bogert, 12-inch cement pipe, $1.10; manholes, $36; street basins, $110. Charles Hart, $1, $36, $109. Edward Gorman, $1.10, $37, $105. Thomas Newman, $1.15, $40, $100. John Bray, 90c., $37, $100. *Stockholm street*; Charles Hart, 15-inch cement pipe, $1.37; manholes, $36. John Bray, $1.30, $37. Thos. Newman, $1.25, $37. Edward Gorman, $1.15, $33. *Dean Street*; Charles Hart, 12-inch cement pipe, $1.09; 15-inch, $1.37: manholes, $36. Thomas Newman, $1, $1.15, $38. John Bogert, $1.05, $1.40, $45. John Bray, 90c., $1.25, $37. Edward Gorman, 90c., $1.25, $34. *District No. 24, Subdivision No. 35*; Charles Hart, 12-inch cement pipe, $1.07; 15-inch, $1.33; 18-inch, $1.59; manholes, $36; street basins, $109. John Bogert, $1, $1.40, $1.50, $35, $110. John Bray, 90c., $1.25, $1.40, $37, $100. Thomas Newman, 95c., $1.20, $1.35, $38, $95. Edward Gorman, 80c., $1.05, $1.25, $30, $100.

Specifications for Sixteenth Street Viaduct, in the City of Omaha, Nebraska.

General Description.—The viaduct will begin at south line of Leavenworth street and terminate at south line of Pierce street; having a total length of 1,500 feet, nearly. The structure will consist of one Howe truss of 150 foot span, three Howe trusses of 96 foot spans, ten trapezoidal 50 foot spans, one skew span consisting of one 50 foot trapezoidal truss and one 30 foot triangular truss, and pile bents at north approach and between U. P. and B. & M. tracks, as indicated on drawings.

The 150 foot span, and two of the 96 foot spans will be supported by four pair of stone piers.

The 96 foot Howe truss crossing B. & M. track, will be supported by pile bents.

The eleven 50 foot spans will be supported by trestle bents on top of pile bents.

The viaduct will have a roadway 20 feet in width, and two elevated sidewalks each 6 feet in width, making a total width of 32 feet nearly. The height of roadway above surface of ground given in figures, is approximate only.

The viaduct will decline from Leavenworth to Mason street, and from Pierce to Mason street, on a slope of about 3 feet in 100 feet.

The drawings and specifications are intended to cooperate, so that if there is anything shown on drawings and not mentioned in the specifications, or *vice versa*, same will be done as though shown on drawings and mentioned in specifications.

The materials and workmanship of the several kinds will be of strictly first class in grade and quality; and to the entire satisfaction of the Board of Public Works and City Engineer.

Monthly payments will be made to the contractor, for the material furnished and labor performed, less twenty per cent., which twenty per cent. will be retained until all is completed and accepted by the City Engineer and Board of Public Works, and approved by the Mayor and City Council. All estimates will be made by the City Engineer, subject to approval as above.

The entire structure shall be completed and ready for use on or before September 1, 1886.

Excavation.—Excavate for stone piers to depth of 4 feet, below ground line. And when masonry is carried above ground, the excavated ground will be banked around piers to height of 2 feet and width of 5 feet, on a slope.

Stone Piers.—The foundations for piers will be carried 4 feet below surface of ground, and shall be of good concrete, composed of broken stone, not more than one and one-half inch in diameter, best American hydraulic cement, and best clean bank sand, in proportions of one of cement to two of sand. The masonry shall consist of a first-class quality of lime or sand stone, to be approved by the Board of Public Works, laid in regular courses throughout. No courses shall be less than 10 inches thick, the joints shall be vertical and horizontal, and the vertical joints shall break not less than 12 inches. Vertical joints shall be close, at least eight inches back from face. Stone piers will be built with a batter of ¾ inch to the foot as shown on detail drawings.

A pitch draught will be used throughout, except at the angles where a neat chisel draft, 11-2 inches wide will be cut. No stretchers shall be less than 2½ feet long, nor less than 11-2 feet bed; and in no case shall the bed be less than 1¼ times the height of the course. The headers shall not be less than 3 1-2 feet long, nor less than 1 1-2 feet in width, and always as high as wide. All face stone shall be laid flush with close joints on their quarry beds.

Not less than thirty per cent. of the face of the walls shall consist of headers, evenly distributed. The copings will be in one piece 5 feet and 2 inches, by 5 feet and 2 inches, by 10 inches thick, neatly cut, with wash of 2 by 2 inches, and be of Colorado or other equally good quality of sand stone. The backing or inside masonry shall be large well shaped stones, and the whole must be well bonded, and laid in good hydraulic cement mortar. All face joints well cleansed and neatly pointed.

Piling.—All piles used must be either burr oak or white oak, and of sizes as may hereafter be specified. They will be straight and true, have limbs closely trimmed, and all bark removed before being driven. They will be free of all defects that will mar appearance, or durability, and will all be subject to inspection by the Board of Public Works, and Engineer in charge of work; who shall have the power to reject all that in their opinion do not conform to the spirit of these specifications.

The piles supporting trestle work under 50 foot spans will be not less than 14 inches in diameter at butt, and 10 inches at top end. They will be driven with top down, and of lengths as follows: Bents, I and II, 20 feet long; bents III and IV, 22 feet long; bents V and VI, 24 feet long; bents VII and VIII, 26 feet long; and bents IX and X, 28 feet long.

The piles used in pile bents on north approach will be 14 inches at butt end, and 10 inches at top end, and of length as follows: Bents B, C and D, 16 feet long; E, F and G, 18 feet long; H, I and J, 22 feet long; K and L, 24 feet long; M and N, 30 feet long; and "O" will be 36 feet long, with two outside piles 16 inches in diameter at butt, and 8 inches at top end.

The pile bents between U. P. and B. & M. tracks will have piles 24 feet, 22 feet, 20 feet and 18 feet respectively, and will be of some diameter as specified for north approach.

The pile supporting the 96 foot span over the B. & M. tracks will be 18 feet in length and 14 inches at butt ends, and 10 inches at top ends. Short pile heads will be used for supporting mud-sill at south approach.

All piles will be driven so that not more than 1 foot will be cut off: they will be so pointed as to drive plumb; and all will be hooped with a heavy wrought-iron ring, on butt end to prevent from splitting or shattering during progress of driving.

Care must be taken in driving piles so that all will line and give full bearings to caps.

All piles, unless otherwise shown on drawings, will have tenons 2 1-2 inches, by 10 inches, by 5 inches. The bearings for caps will be carefully framed to right angles thereto.

Cross-Bracing.—All piles extending more than 6 feet above ground, except those from "B" to "J" on north approach, will be cross-braced with 3 inch by 12 inch pine; piles faced at intersection of braces so as to give an even bearing; and bolted with ¾ inch bolts, with cast-iron washers at each end of bolts.

Caps.—All caps will be 12 inches by 12 inches pine, and of length marked on drawings. The caps for the support of 96 foot span crossing B. & M. track will be 12 inches by 12 inches oak All caps will be tenoned to piles with 2 1-2 inch by 10 inch by 5 inch mortise, and pinned with ¾ inch oak pins. The caps running parallel with bridge will have ¾ inch round by 8 inch long iron dowels, as shown. All caps will be free from shakes, bad knots, or any defects that may impair their looks or durability. The Engineer in charge will give heights for top of caps at each bent.

Trestle Work.—The ten 50 foot spans will be supported by trestle as indicated on detail drawings. All trestles above pile bents will be of uniform height. The trestles throughout will be of white pine or long leafed southern pine lumber, of dimensions marked on drawings. The center posts will be 12 inches by 12 inches, battering posts 10 inches by 12 inches, cross-bracings, 3 inches by 8 inches, longitudinal cross bracing 4 inches by 8 inches. The center posts will be tenoned into upper cap, which will be 12 inches by 12 inches, 24 feet long, and pinned with ¾ inch oak pins to be bored to draw ½ inch. All of the posts will be tenoned into lower cap and drawbored and pinned with ¾ inch oak pins. All timbers will be framed to net sizes at intersections. All braces and ties will be bolted with ¾ inch bolts and cast-iron washers. The long braces on upper caps will be nailed at two posts, as shown, with 8 inch boat spikes. The tenons on posts will be 2 inches by 8 inches, by 5 inches long. All to be framed in a neat and workmanlike manner. The lumber throughout to be free from splits, shakes, injurious knots or all defects that may impair its durability or appearance.

Cast-Iron.—The 50 foot spans will have cast-iron shoes where pin connections are, for receiving vertical posts. The upper shoes will have dowels cast on as shown. The lateral angle blocks will be of cast-iron. All end washers, and packing washers, spool washers, beveled washers, and lateral washers, will be of cast-iron, according to detail drawings. All the angle blocks, lateral blocks, tubes, packing washers, end washers, lateral washers, spool washers, of the three 96 feet spans, and of the 150 foot span will be of cast-iron according to detail drawings. Each and every angle block, (excepting end angle blocks) of the three 96 feet spans will have two tubes, while those of the 150 foot span will have three tubes, as per details. All of the cast-iron work will be free from defects that may impair its durability or mar its appearance. The shoes at pin connections will have 2⅛ inch holes drilled as shown. The upper angle blocks will have ¾ inch holes drilled for dowels as shown.

Wrought-Iron.—The truss rods of the three 96 foot spans, and the 150 foot span, and the lateral rods of the same spans, and lateral rods, main and counter rods, and eye bars of the 50 foot spans, will be made of double refined wrought-iron of sizes marked on drawings and details.

All rods will be upset at both ends with hexagon nuts of proportions as recommended by the Franklin Institute. The eye bars will be hydraulic forged of forms as shown on detail drawings. There will be no welding permitted on either rods, eye bars or eye rods. The upsets will be formed by being rolled to shapes required.

The iron used in tension rods and bars will have an ultimate tensile strength of 50,000 pounds per inch, sectional area; and must not have a permanent set, under a load of 25,000 pounds per inch, sectional area, it must be sufficiently elastic to admit of its being bent around a curve, radius of two diameters of rod, at an angle of ninety degrees without showing cracks or signs of breaking on outer curve. The pitch of threads, etc., will be according to formula adopted by the "Franklin Institute."

The gibb plates and end plates will have clean cut holes of sizes marked in list. The pins, for pin connections, will be made of extra quality refined iron and turned to size marked on drawings, with 1¼ inch thick hexagon nuts at ends as shown. All dowels, bolts, ferrules, etc., will be of sizes marked on plans or herein specified. The reduction of breaking area, or rods and bars, shall average 25 per cent.; and the elongation of rod or bar before rupture must not be less than 15 per cent.

Howe Trusses.—Frame and erect a 150-foot span Howe truss, with bottom chords of two pieces of 7 inches by 16 inches and two pieces of 6 inches by 16 inches, with 3 inches by 16 inches by 12 inches oak packing blocks, gained ¾ of an inch into timbers, as shown. The length of timbers in chords will be of lengths marked on drawings. Gain bottom chord ¾ inch for cast-iron tubes where and as shown, having same fit closely. Frame the top chords of two pieces 7 inches by 14 inches, and two pieces of 6 inches by 14 inches of lengths marked on drawings, and pack with 2⅛ inches by 14 inches by 12 inches pine packing blocks, gained ½ inch into timbers. Gain cut for cast-iron tubes in upper chord ¾ inch deep, to fit closely.

The bottom chords will be framed to 12 feet 6 inches to center of panels, while the top chords will be 12 feet 6¼ inches from center of panels. The main and counter braces will all be of same length, and latter will have a ¾ inch round by 5 inch long iron dowel at upper end to extend into angle block. The main ends struts will be packed similar to top chord where shown. All of the splices will be made so that ends of timbers will joins closely together.

The lateral braces will be spaced as shown on skew plans. Each of the end angle blocks will be secured with three 1-inch round bolts.

The three 96-foot Howe trusses will have bottom chords of three pieces of 6 inches by 12 inches, packed with 3 inches by 12 inches by 12 inches oak packing, gained ¾ inch into timbers. The top chords will be packed with 2½ inches by 10 inches by 10 inches pine The end struts will be packed as shown, with 2½ inches by 10 inches by 10 inches pine packing. The top chords will be made of three pieces of 6 inches by 10 inches. The bottom chord will be framed to 12 feet center of panels, while top chords will be framed 12-feet and ¼-inch center of panels. The braces throughout will be framed of uniform length. The counter braces, at top ends, will be doweled to angle blocks with ¾-inch round by 5 inches long iron dowels.

Frame lateral braces of 6 inches by 8 inches, with ¾ inch by 14 inches long round wrought-iron dowel at intersections of braces. Each end of the top chords of the four Howe trusses will have a 6 inch by 8 inch tie bolted on top as shown with ¾ inch bolts and cast-iron washers. These bolts will be bored through timber and not pass between. Each of the end angle blocks on 96-foot spans will be bolted down with two 1 inch by 14 inch bolts.

The 150-foot span and two 96-foot spans will be on a skew of an angle of forty-five degrees and the 96-foot span crossing *B.* and *M.* track will be on a skew of 28 in 20 as shown.

The bearings of angle blocks and gibb plates will be carefully sized corresponding to length of tubes. Each and every angle block (except end angle blocks) on the 96-foot spans, will have two cast-iron tubes extending through chords to take bearings off of chords.

All of the packings will be carefully dressed to sizes given, and the timbers will be so gained out, so that each and every packing will be tightly driven in place with a heavy wooden maul, after which all will be bolted with ⅞-inch bolts, and drawn tightly together on cast-iron washers at both ends of bolts. All packings will have two bolts as shown, and where joint in pieces occur on outside, same will have two bolts as shown on the 150-foot span, and one bolt on the 96-foot spans. The gains for angle blocks will be gained out, after chords are bolted together. Each floor beam coming on chords of 150-foot, and 96-foot spans will be bolted thereto with ¾-inch bolts, without boring chords. All intersections at braces will be bolted, with packing washers between mains and counters, of sizes marked and cast-iron washers at both ends of bolts.

In the erection of Howe trusses over railroad tracks, the false work will be so placed as not to interfere with traffic on any of the tracks; and when ready to "draw up" truss rods, same will be done under the direction of engineer-in-charge. Place 3-inch by 12-inch hub-rails on the four Howe trusses bolted to main braces with 1-2-inch round head bolts, and machine washers. When hub-rail is bolted to counter braces, same will be provided with 1-inch gas pipe ferrule of sufficient length to bring rail true, and to have machine washers at ends as shown. Place 4 by 6-inch oak pieces on floor below hub-rail as shown, spiked down with 8 by 1-2 inch boat spikes.

Fifty-Foot Trusses.—Frame, upper chords of three pieces, 6 inches by 12 inches pine, and of lengths marked on drawings. These chords will be packed with 1-inch packing washer as shown. The packing washers through which laterals pass will be of same size as others, but will have hole 1⅛-inch in diameter.

Frame, vertical posts of 8 inch by 10 inch pine, to be closely fitted into cast-iron shoes as per detail drawings.

Cross brace posts with 5 inch by 5 inch pieces, pine, and bolt to posts as shown, with 1-2 inch bolts, and machine washers. Bolt braces together at intersection with 1-2-inch bolt and 1-inch gas pipe ferrule, with machine washers as shown. Place lateral braces of 6 inch by 8 inch, pine, with ¾ inch by 14 inch long, round wrought-iron dowls.

The ends of top chords will be cut at right angle to iron rods as shown. When the iron rods pass between chord timbers, the chord timbers will be gained out just enough to admit rods, and in line thereof.

All of the 50 foot spans will be secured to cap on which they rest, with 6 inch long wrought-iron dowls, 1-inch in diameter, to extend 3 inches into cap, and 3 inches into middle chord timbers. The ends of chords will be bolted to ends of 6 inch by 12 inch stringers as shown with ¾ inch bolts.

All of the floor beams, except those coming near ends of truss will be bolted to chords with ¾ inch bolts, and cast-iron washers at each end without boring chord.

In drawing up rods care will be taken not to draw counters until mains are so drawn so that there will be ¾ inch cambers in middle, and the post at right angle to top chord, after which the counters will be drawn, but not too tightly.

Floor System.—The entire system will be as shown on drawings, with twenty-three longitudinal 2 inch by 12 inch pine stringers, cross bridged at between every floor beams, with 1 1-2 inch by 3 inch pieces nailed with three 10d nails at each end. All of the floor beams will be of sizes marked on plans, and will be packed with 1 inch by 3 1-2 inch packing washers, and bolted with ⅞ inch bolts with cast-iron washers at each end, and to be bolted to chords and stringers underneath with ⅞ inch bolts, and cast-iron washers at both ends.

Nail tapering or wedge-shaped pieces, 10 inches wide over all floor beams, to give the driveway a crown of 2 inches as shown. Lap and spike together with 20d nails all the 2 by 12 stringers, as shown. The sub-floor in roadway will be of 2 inch white pine plank, surfaced to thickness, joined over stringers, laid at an angle of 45 degrees, and nailed at every bearing with 40d nails. All plank 10 inches wide and under will have two spikes, and over 10 inches have three spikes at each bearing.

The sidewalk joist will be 2 by 8 inches, spaced as shown, and spiked to stringers and hand rail posts. At every post extend joist 2 feet on which post will be braced. The entire upper floor, for driveway and sidewalk, will be of 2 inch white oak plank, and in roadway will be laid at right angle to stringers. All of the plank for roadway will be 10 feet long, and no head joints will be permitted. Place a feather edge piece 8 inches wide at each side of roadway to form gutter, and cap the center with a piece of 4 by 6 inches spiked down with 8x1-2 inch boat spikes.

Lay sidewalk with 2 inch white oak plank, laid longitudinally with the bridge and head joints broken at every plank. All of the oak plank will be nailed with 40d nails over each stringer. All plank 10 inches and under will have two spikes, while plank over 10 inches wide will have three spikes. No plank in either road way or sidewalk must be more than 12 inches wide, or vary in thickness more than ¼ inch.

There will be small openings along gutter line at every 50 feet through which surface or rain water will be drained. These openings will be in form and at points engineer-in-charge may designate.

On the inside ends of the 2 by 8 inch joists, a 2 by 8 inch piece placed on edge and spiked into each end of joist, as shown. The sidewalk plank must not be less than 12 feet in length, and head joints must be trimmed off. All of the lumber used will be free of defects that may impair its durability or mar its appearance.

Hand Rail.—Place 4 by 5 inch posts at every floor beam of white pine and bolted to stringers and joist as shown. The post will be braced with 1 by 6 inch pine, nailed at both ends with five 10d nails, and gained into post 1 inch. The posts will be bolted to stringers as shown, with two 1-2 inch bolts and machine washers. Nail three 1 by 6 inch, equally spaced on posts with three 10d nails, at each bearing. Break joints at every post. Cap posts with 4 by 6 inch beveled hand rail, mortised and tenoned into rail, and pinned with oak pin as shown.

Bridge Seat.—The Howe trusses will have oak bridge seats on stone piers of sizes shown, bolted together with ¾ inch bolts, cast-iron packing, and end washers as shown.

Liability of Contractor.—The Contractor shall be held responsible for any delays caused by the rejection of materials or workmanship, of any part of the structure, when such rejection is due to a violation of these specifications, or conditions of contract.

It is understood and agreed that no claims whatever will be made or allowed, for extra work or material, unless some changes or additions to the work specified, or shown on the drawings, requiring additional outlay by the contractor, shall have first been ordered in writing by the Board of Public Works.

The contractor will be required to guard the public effectually from liability to accident in consequence of his operations during the whole progress of the work both by day and by night, and will be held responsible for any damages the city may have to pay in consequence of neglect on the part of the contractor to protect the public against such accidents. The contractor will also be held responsible for all damages said city may have to pay to private individuals or corporations in consequence of the acts or doings, or neglect of said contractor in connection with said work.

Trade Notes.

THE BRITISH IRON TRADE IN 1885.—The following statistics are taken from the advance sheets of the report of the report of the secretary of the British Iron and Steel Association, and give the total production of British iron and steel of all kinds in 1885, the exports consumption and stocks for the same period, and also figures showing the world's production of pig and manufactured iron and Bessemer steel. Some particulars in regard to shipbuilding are also shown. Comparisons with previous years are appended.

Description	1883, *tons.*	1884, *tons.*	1885, *tons.*
Production of pig iron	8,490,224	7,528,966	7,250,657
Stocks of pig iron on December 31	1,698,978	1,809,467	2,352,169
Home consumption pig iron	8,449,368	7,383,475	6,707,955
Production hematite iron	3,287,000	2,770,000	2,560,000
Production spiegeleisen	208,445	166,828	141,497
Production puddled bar	2,730,501	2,240,535	1,911,125
Production Bessemer steel ingots	1,553,380	1,299,676	1,304,129
Production of Bessemer steel rails	1,097,174	784,968	706,583
Production open-hearth steel	455,500	475,250	583,918
Production of coal in the United Kingdom	163,737,327	160,757,000	159,351,000
Shipbuilding, tonnage constructed	1,329,603	723,016	540,371
Shipbuilding in course of construction at end of year	729,446	373,808	318,567
Exports pig iron from United Kingdom	1,561,137	1,369,677	960,000
Exports of railroad iron	971,662	729,236	711,000
Total exports iron and steel	4,044,273	3,496,352	3,128,401
The world's production of pig iron	.....	19,148,585	18,707,369
The world's manufactured iron	.....	7,709,590	6,889,449
The world's Bessemer steel	.....	4,845,412	4,973,420

THE IRON TRADE AT HOME AND ABROAD.

The English press make the unvarnished statement that "the British iron trade is in the throes of a crisis." This is based on declines in home consumption and exports, and increases in stocks and (in some districts) production. As pointed out in *Bradstreet's* a few weeks ago, in order to check the continued depression in the British pig iron industry a call has been issued by makers to arrange for a restriction of output for one year amounting to twenty five per cent. The Manchester *Guardian* points out that a few years ago the United Kingdom used to supply the bulk of the requirements of the United States and a large proportion of the requirements of the continent. "But," says that journal, "turning to the statistics of the United States we find that the production there has greatly expanded. The average outturn of the five years, 1871-5, was 2,340,000 tons, while the average production of the last five years was 4,296,000 tons. Germany in 1871-5 produced an average per annum of 1,907,000 tons to contrast with 4,811,000 in the last five years. France and Belgium together in the five years ended 1875 produced 1,845,800 tons a year; the outturn in the five years ending 1885 reached an average of 2,640,000 tons. The countries named, therefore, showed an increase in make of nearly 100 per cent. in a decade. The average production of the United Kingdom in 1871-5 was 6,460,000 tons, rising in the last five years to 8,060,000 tons, an increase of twenty-five per cent."

Returning to the plan to stimulate demand through reduced output, it is asked: "If low prices will not stimulate consumption, will higher prices do so? If unfavorably situated furnaces cannot compete with well-placed ones at present values of the produce, can we expect that the proprietors of the latter will agree to make way for their weaker brethren?" From such considerations as these the inference is drawn that the plan will fail of its object.

This view of the situation may be supplemented with the following from Sir Lowthian Bell, F. R. S., in his lately published report of the British metals industries with respect to the effect on them of foreign competition. The conclusions, in brief, are:

That minerals used in the iron trade occur in the United Kingdom under circumstances as favorable for economical extraction as in any foreign iron-making country.

That we can smelt foreign ores with greater economy than can be done by any other nation.

That raw materials used in the manufacture of iron, as a whole, are obtained as cheaply as in any neighboring country.

That railway accommodation for the transport of fuel, ore and limestone is afforded on terms somewhat cheaper in Great Britain than those charged on the continent for like distances. Further, that the geographical position of our minerals is such that they can be brought to the smelting works at a less outlay per ton of pig iron than is usually done abroad; and at the same time our furnaces, etc., are so placed that their produce can either be shipped at a mere nominal cost or the expense for this work does not in any case greatly exceed one-half of that incurred at the best situated foreign works.

That, partly owing to the greater proximity of British minerals to the smelting works, partly to the more general adoption of labor-saving arrangements, and in some measure to the character of our men, in spite of dear labor, the ore is smelted and the resulting pig iron is converted into malleable iron or steel at a cost taken as a whole, not differing materially from what similar work is performed for in Germany, France or Belgium.

I deem it impossible that *cheaper labor or greater manufacturing skill* places foreign works in a position to produce and ship iron more cheaply than is done in our own country for purposes of exportation.

In machinery-making, as well as in ship-building, we stand, in point of amount, greatly in advance of all foreign countries.

That the geographical position of iron ore and fuel in the United States, as at present known, renders it impossible that the iron trade, as carried on in the northern portion of the Union, can ever become one of a largely exporting character.

That scientific knowledge is applied as generally in the manufacture of iron in Great Britain as it is on the continent.

At the present moment it is difficult to conceive the creation of any enterprise which will require for its prosecution the amount of iron which has been absorbed by railways on land or by ships on the sea. We must, therefore, rather look for an increased consumption among the millions of people who at present are consumers of very limited quantities of the metal. This, the experience of the last few years, induces me to hope may happen sooner than is expected by some people.

The long and short of it appears to be that the English ironmasters can turn out their products as cheaply as their rivals. But the world's available supply sources (finished metals) have grown enormously within five years, and reduced demands, after seasons of excessive railway and steamship building, are pinching manufacturers in Germany, Belgium, England and France.

The United States industry is dealing, so far as finished metals are concerned, with practically the home demand, the exports cutting no very great figure in point of total value. The production has, of course, been checked to meet the existing demands, which are still considerable. Inasmuch as American iron and steel works have never been yet called on to supply a large foreign demand, the proportion of depression and the restriction of output noted abroad is not seen here even with excessive continental competition.—*Bradstreets.*